

2ND INTERNATIONAL CONGRESS OF
ENTOMOLOGY

OXFORD, AUGUST 1912

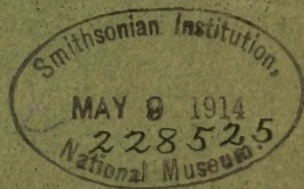
VOLUME I
PROCEEDINGS

BY
K. JORDAN AND H. ELTRINGHAM

ASSISTED BY
H. ROWLAND-BROWN, J. J. WALKER
AND THE
SECRETARIES OF SECTIONS

WITH FRONTISPIECE AND TWO PLATES

OXFORD
FEBRUARY 1914



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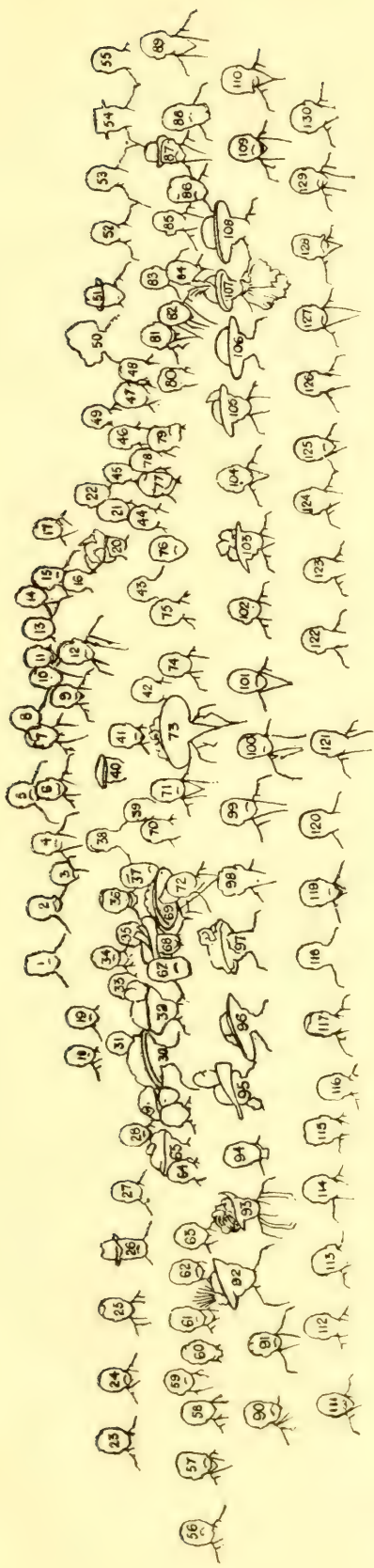
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VOLUME I
PROCEEDINGS

SECOND INTERNATIONAL CONGRESS OF ENTOMOLOGY. 1912



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3. Dadd, E. M.
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15. Hoff, J. E.
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30. Rowland-Brown, Miss
31. Ball, F. J.
32. Wheeler, Mrs. G.
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70. Clavereau, H.
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72. Arrow, G.
73. Horvath, Miss
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75. Suraya, M.
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94. Fowler, W. W.
95. Cameron, Mrs.
96. Jordan, Miss
97. van Bemmelen, Mrs.
98. van Bemmelen, J. F.
99. Horvath, G.
100. Severin, G.
101. Poulton, B. B.
102. Lameere, A.
103. Kolbe, H. J.
104. Kolbe, H. J.
105. Schouteden, Mrs.
106. Kerrenans, Miss
107. Boppe, Mrs.
108. Horn, Mrs.
109. Ferrant, V.
110. Forbes, S. A.
111. Calvert, P. P.
112. Sommet, N. S.
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122. Gahan, C. J.
123. Morris, Sir D.
124. Rudok, F.
125. Carpenter, G. H.
126. Robson, R.
127. Druce, H. H.
128. Boppe, P. L.
129. Horn, W.
130. Skimer, H.

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THE PROCEEDINGS OF THE ENTOMOLOGICAL CONGRESS, 1912

PRELIMINARY ARRANGEMENTS FOR THE CONGRESS.

AT the first International Congress of Entomology, held in Brussels in 1910, it was unanimously decided to hold the second Congress at Oxford in 1912, with Professor E. B. POULTON, D.Sc., F.R.S., as President.

Early in 1912 a local Committee was formed for the purpose of carrying out all the preliminary arrangements connected with the local organisation.

This Committee consisted of the following :

Dr. F. A. DIXEY, D.M., F.R.S., Chairman.

Professor G. C. BOURNE, D.Sc., F.R.S.

Professor H. L. BOWMAN, D.Sc.

Professor SELWYN IMAGE, M.A., F.E.S.

Dr. G. B. LONGSTAFF, D.M., F.E.S.

Professor E. B. POULTON, D.Sc., F.R.S.

Mr. G. W. SMITH, M.A.

Commander J. J. WALKER, M.A.

Mr. H. ELTRINGHAM, M.A., F.E.S.

Mr. G. H. GROSVENOR, M.A., F.E.S.

The two last named acted as Honorary Secretaries.

With the kind permission of the Delegates of the University Museum it was arranged to hold the meetings of the Congress in that building, and a General Office, Lecture Rooms, Exhibition Rooms, and Reading Rooms were placed at the disposal of members.

The following Colleges kindly offered rooms for visitors : Jesus, Lincoln, Merton, Magdalen, New College, Queen's, and Wadham.

Private hospitality was kindly offered by many Oxford residents, and several of the owners of neighbouring estates generously invited parties to visit places of interest in the neighbourhood.

Preliminary arrangements were made for excursions to :

- (1) Youlbury, by kind invitation of Sir Arthur Evans, F.R.S.
- (2) Nuneham, by kind invitation of the Rt. Hon. L. V. Harcourt, M.P.
- (3) Bagley Wood, by kind invitation of the President and Fellows of St. John's College.
- (4) Cornbury Park, by kind invitation of Mr. Vernon Watney, M.A., New College, and Lady Margaret Watney.
- (5) Wytham Park, by kind invitation of C. A. J. Butler, Esq.

Finally the Hon. WALTER ROTHSCHILD, Ph.D., F.R.S., generously invited the whole of the members of the Congress to visit Tring Park and view his celebrated private collections.

The Warden of Wadham College kindly placed his garden at the disposal of the Committee for the erection of a private café for the use of members during the Congress, and permission was obtained from the authorities of Christ Church, through the good offices of the Chairman, to hold the banquet in the hall of that College. The Committee further arranged for the manufacture of the badges to be worn by the members, and these were constructed from a design specially made by Professor SELWYN IMAGE, Slade Professor of Fine Art in the University of Oxford.

It was arranged that a guide to Oxford should be issued to every member of the Congress, and Commander WALKER undertook to prepare a special supplement giving an account of the local flora and fauna, and an account of the Hope Collections was kindly furnished by Professor POULTON.

In the meanwhile circulars were sent out by Dr. MALCOLM BURR, the General Secretary, and as the applications for rooms

were received by him they were forwarded to Oxford, where the local Secretaries duly allotted rooms and sent advices to the applicants.

As the time for the Congress approached, it was felt that all that careful forethought could do for the final success of the meeting had been accomplished. It would seem that even Entomological Congresses are not immune from the disappointments which proverbially attend the best-laid schemes, whether of man or of humbler creatures. At the last moment Dr. MALCOLM BURR, our General Secretary, who throughout had been indefatigable in his endeavours to promote the welfare of the meeting, was obliged to inform the Committee that owing to the continued illness of Mrs. BURR it would be impossible for him to proceed to Oxford to attend to the final arrangements. It at once became evident that, owing to the necessary transference of the whole of the correspondence, papers, etc., it would be impossible to issue the programme before the opening of the Congress. Dr. BURR very kindly sent his private secretary, Mr. LOESCH, to Oxford with all the papers, and Dr. JORDAN at once proceeded to Oxford to assist the local Secretaries. As the result of their combined labours, together with the enterprising promptness of the printers, the most important documentary item, the Official Programme, was completed in time for the reception held on Sunday evening, August 4th.

Arrangements were made for every train from London to be met by a representative of the Congress, so that strangers might be given the necessary information to enable them to find their rooms. Mr. H. ROWLAND-BROWN, Mr. R. S. BAGNALL, and others very kindly assisted in this manner.

On Sunday evening, August 4th, at 8.30, the members of the Congress were invited by Oxford entomologists to an informal reception in the hall of New College, kindly lent by the Fellows for that purpose. Light refreshments were provided, and a most enjoyable evening was spent, a very large number of the members being present.

Each member was presented with a package containing the guide to Oxford, a copy of the programme, and the badge of the Congress.

LIST OF GOVERNMENTS, UNIVERSITIES, INSTITUTIONS, MUSEUMS, AND SOCIETIES, PATRONISING THE SECOND CONGRESS OF ENTOMOLOGY, AND REPRESENTED BY DELEGATES.

AUSTRALIA.

1. *Commonwealth Government.*
Delegates : Prof. F. V. Theobald.
Dr. Tidswell.
2. *Government of Western Australia.*
Delegate : Sir N. J. Moore, K.C.M.G.

BELGIUM.

3. *Ministre des Colonies, Bruxelles.*
Delegate : Dr. H. Schouteden.
4. *Musée du Congo Belge, Tervueren.*
Delegate : Dr. H. Schouteden.

CANADA.

5. *Department of Agriculture, Dominion of Canada.*
Delegate : Dr. C. Gordon Hewitt.
6. *Entomological Society of Ontario.*
Delegate : Dr. C. Gordon Hewitt.

FRANCE.

7. *Muséum d'Histoire Naturelle, Paris.*
Delegates : Ferdinand le Cerf.
Eugène Boulet.

GERMANY.

8. *Berliner Entomologischer Verein, E.V., Berlin.*
Delegates : Prof. H. J. Kolbe.
E. M. Dadd.
F. Wichgraf.
9. *Deutsches Entomologisches Museum, Berlin-Dahlem.*
Delegates : Dr. W. Horn.
Sigm. Schenkling.

10. *Entomologisches Cabinet der Zoologischen Bayrischen Staatssammlung.*

Delegate: Baron Kurt von Rosen.

11. *Königliches Museum für Naturkunde, Berlin.*

Delegate: Prof. H. J. Kolbe.

GREAT BRITAIN AND IRELAND.

12. *Board of Agriculture and Fisheries.*

Delegates: Dr. R. Stewart MacDougall, M.A., D.Sc., F.E.S.

A. G. L. Rogers, M.A.

13. *Colonial Office.*

Delegates: Hon. N. C. Rothschild, F.E.S.

G. A. K. Marshall, F.E.S.

14. *Armstrong College, Newcastle-upon-Tyne.*

Delegate: R. A. H. Gray.

15. *Birmingham Natural History Society, Entomological Section.*

Delegates: Sir George Kenrick, F.E.S.

W. Bowater, B.D.S.

16. *British Museum (Natural History).*

Delegates: Hon. Walter Rothschild, Ph.D., F.R.S.

C. J. Gahan, M.A., F.E.S.

17. *County Council of Lanark, Hamilton.*

Delegates: William Templeton.

James C. Pollok.

18. *Edinburgh and East of Scotland College of Agriculture.*

Delegate: Dr. R. Stewart MacDougall, D.Sc., F.E.S.

19. *Entomological Society of London.*

Delegates: Rev. F. D. Morice, M.A., F.E.S. (President).

Rev. George Wheeler, M.A., F.E.S. (Secretary).

G. T. Bethune-Baker, F.E.S.

Hon. Walter Rothschild, Ph.D., F.R.S.

H. Rowland-Brown, M.A., F.E.S.

20. *Essex Education Committee.*

Delegate: R. Robson.

21. *Horticultural Society.*

Delegate: Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L.

22. *Imperial College of Science and Technology, London.*

Delegate: H. Maxwell Lefroy, M.A., F.R.S.

23. *Linnean Society of London.*
Delegate : Roland Trimen, M.A., F.R.S.
24. *Literary and Philosophical Society, Newcastle-upon-Tyne.*
Delegate : R. S. Bagnall, F.E.S.
25. *National Museum, Dublin.*
Delegate : J. H. Halbert.
26. *Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne.*
Delegate : John Gardner, F.E.S.
27. *Newcastle Free Libraries.*
Delegate : R. S. Bagnall, F.E.S.
28. *Oxfordshire Education Committee.*
Delegate : G. R. Bland.
29. *Public Libraries, Museum, and Art Gallery, Sunderland.*
Delegate : R. S. Bagnall, F.E.S.
30. *Royal Agricultural Society of England, London.*
Delegate : Cecil Warburton, M.A.
31. *Royal Colonial Institute.*
Delegate : Sir Daniel Morris, K.C.M.G., D.Sc., D.C.L.
32. *Royal Society.*
Delegate : D. Sharp, M.B., F.R.S.
33. *South-Eastern Agricultural College, Wye.*
Delegate : Prof. F. V. Theobald, M.A., F.E.S.
34. *South-Eastern Union of Scientific Societies.*
Delegate : Alfred Sich, F.E.S.
35. *The Scottish Microscopical Society.*
Delegate : Miss L. H. Huie, F.E.S.
36. *University Museum of Zoology, Cambridge.*
Delegates : A. E. Shipley, M.A., F.R.S.
Prof. R. C. Punnett, M.A., F.R.S.
C. Warburton, M.A.
Hugh Scott, B.A., F.E.S.
37. *University of Edinburgh.*
Delegates : Dr. R. Stewart MacDougall, D.Sc., F.E.S.
Dr. J. H. Ashworth.
38. *University of London.*
Delegates : Prof. F. V. Theobald, M.A., F.E.S.
Dr. W. N. F. Woodland.

39. *University of Oxford.*

Delegates : Dr. F. A. Dixey, F.R.S.

Rev. Francis D. Morice, F.E.S.

40. *Vale of Derwent Naturalists' Field Club.*

Delegate : R. S. Bagnall, F.E.S.

41. *Zoological Society of London.*

Delegates : Dr. P. Chalmers Mitchell, F.R.S.

G. A. K. Marshall, F.E.S.

HUNGARY.

42. *Royal Ministry of Agriculture.*

Delegate : J. Jablonowski.

43. *The Royal Hungarian Society of Natural Sciences, Budapest.*

Delegate : Dr. G. Horváth.

44. *Entomological Society of Hungary.*

Delegate : J. Jablonowski.

45. *A Magyar Nemzeti Museum.*

Delegate : Dr. G. Horváth.

INDIA.

46. *Indian Museum, Calcutta.*

Delegate : Dr. Nelson Annandale.

LUXEMBOURG.

47. *Gouvernement de Luxembourg.*

Delegate : Victor Ferrant.

48. *Société des Naturalistes Luxembourgeois.*

Delegate : Victor Ferrant.

NETHERLANDS.

49. *Koninklijk Zoologisch Genootschap "Natura Artis Magistra," Amsterdam.*

Delegate : Prof. Dr. J. C. de Meijere.

50. *Nederlandsche Entomologische Vereeniging, Rotterdam.*

Delegate : Jhr. Dr. Ed. J. G. Everts.

SPAIN.

51. *Institut d'Estudis Catalans, Seccio de Ciencias, Barcelona.*
Delegate : Dr. Joseph M. Bofill.
52. *Museo de Ciencias Naturales, Madrid.*
Delegate : Don R. Garcia y Mercet.
53. *Real Academia de Ciencias y Artes, Barcelona.*
Delegate : R. P. Longinos Navás, S.J.
54. *Razon y Fe, Madrid.*
Delegate : R. P. Longinos Navás, S.J.
55. *Sociedad Aragonesa de Ciencias Naturales, Zaragoza.*
Delegate : R. P. Longinos Navás, S.J.

SWEDEN.

56. *Government of Sweden.*
Delegate : Prof. Yngve Sjöstedt.
57. *Kongl. Vetenskaps-Akademien, Stockholm*
Delegate : Prof. Yngve Sjöstedt.

SWITZERLAND.

58. *La Chancellerie de la Confédération Suisse.*
Delegate : Dr. A. von Schulthess.
59. *Naturforschende Gesellschaft, Zürich.*
Delegate : Dr. A. von Schulthess.

TURKEY.

60. *Ministry of Agriculture of the Ottoman Empire*
Delegate : Mehmed Sureya.

U.S.A.

61. *American Association of Economic Entomologists.*
Delegate : Prof. Herbert Osborn.
62. *American Entomological Society.*
Delegates : Prof. P. P. Calvert.
Dr. Henry Skinner.
63. *The Academy of Natural Sciences of Philadelphia.*
Delegates : Dr. Henry Skinner.
Prof. P. P. Calvert.
Dr. W. J. Holland.

64. *Entomological Society of America.*

Delegates: Prof. J. H. Comstock.
 Dr. Henry Skinner.
 Prof. P. P. Calvert.
 Prof. Herbert Osborn.
 Prof. Vernon L. Kellogg.
 Dr. W. J. Holland.
 Prof. Stephen A. Forbes.
 Dr. W. M. Wheeler.
 Dr. L. O. Howard.
 Dr. J. G. Needham.

65. *The Entomological Society of Washington.*

Delegate: Dr. L. O. Howard.

WEST INDIES.

66. *The Imperial Department of Agriculture, West Indies.*

Delegate: Sir Daniel Morris, K.C.M.G., D.Sc., D.C.I., etc.

THE CONGRESS

THE programme as originally issued to the members had to be modified to some extent during the progress of the Congress. We append here the programme as actually carried out :

SECOND INTERNATIONAL CONGRESS OF ENTOMOLOGY, OXFORD, 1912.

PROGRAMME OF THE CONGRESS.

The Meetings of the Congress will take place in the University Museum Buildings. Members wishing their remarks to be included in the accounts of the proceedings are requested to hand to the Secretaries a note of same with date, name, and Section marked thereon.

EXHIBITS. During the Congress the following exhibits will be on view :
 Dr. F. A. Dixey.—Pierinæ. H. Eltringham.—The African Species of the Genus *Acræa*. Prof. Poulton and A. H. Hamm.—Insects and their Prey, with special reference to the Courtship of the Empidæ.
 Prof. Poulton.—Mimetic Groups.

At convenient times the Exhibitors will explain their exhibits to members of the Congress.

Sunday, August 4th.

The Members of the Congress are invited to an informal Reception by Oxford Entomologists in the Hall of New College, at 8.30 p.m. At this Reception, guides, programmes, and badges will be distributed.

Monday, August 5th.

9.0 a.m. The office of the General Secretary will be open in the Museum, where those members who have not already received their badges, etc., are requested to apply.

10.30. **OPENING OF THE CONGRESS.** **Room A.**

President: E. B. Poulton. Vice-President: G. Horváth.
Secretary: H. Eltringham.

President's Opening Address. Arrangement of Sections.

PAPER: The Hon. N. C. Rothschild, on "Nature Reserves."

Meeting of Presidents and Secretaries of Sections.

2 p.m. **SECTIONS.**

1. Economic and Pathological **Room B.**

President: L. O. Howard. Vice-President: R. Newstead.
Secretary: H. Scott.

PAPERS:—

(a) Sir Daniel Morris on behalf of N. A. Ballou.

"Some Entomological Problems in the West Indies."

Occurrence *Phytalus smithi* Arrow, in Barbados, attacks of
Root Borer on Sugar Cane, Red Maggot, Flower Bud Maggot,
and Leaf Blister Mite on Cotton, and control of certain insects
by natural enemies.

To be read on behalf of

(b) J. Dewitz.

"Die Physiologie in der Schädlingsforschung."

(c) R. Stewart MacDougall.

"*Heteroptera* and *Thripidae* as apple enemies."

[Withdrawn]

2. Systematics and Distribution. **Room A.**

President: Ch. Oberthür. Vice-President: D. Sharp.
Secretary: G. Arrow.

In the absence of both the President and Vice-President, the Hon. N. Charles Rothschild took the Chair.

PAPERS:—

(a) H. J. Kolbe.

"Die Differenzierung der zoogeographischen Elemente der
Kontinente."

In jedem Kontinent und in jeder Zone giebt es zoogeographische
Elemente von ungleichem Werte. Diese sind das Resultat der
Entwicklung während verschiedener geologischer Perioden.

(b) A. Porter.

Insects of Chili.

"A Catalogue and Bibliography of Chilian Coccidæ."

[Withdrawn]

(c) W. Horn.

"Die Fortschritte des neuen Coleopterorum Catalogus von
Junk-Schenkling."

Tuesday, August 6th.

10 a.m.

GENERAL MEETING.

Room A.

President: A. Lameere. Vice-President: J. van Bemmelen.
Secretary: H. Eltringham.

PAPERS:—

(a) J. H. Comstock.

"The Silk of Spiders and its Uses."

A description of the different kinds of silk spun by spiders and of the use of each kind. Illustrated by lantern slides made from photomicrographs of silk and from photographs of webs.

11 a.m.

SECTION.

Evolution, Bionomics, and Mimicry.

Room A.

President: Y. Sjöstedt. Vice-President: H. Skinner.
Secretary: L. Doncaster.

PAPERS:—

(a) E. B. Poulton.

"Mr. C. A. Wiggins's and Dr. G. H. Carpenter's researches in mimicry in the forest butterflies of Uganda."

(b) R. C. L. Perkins.

"The Colour Groups of Hawaiian Wasps."

(c) The Rev. K. St. A. Rogers.

"Mimicry in the two sexes of the E. African Lycænid *Alæna picata* E. M. Sharpe."

2 p.m.

SECTIONS.

I. Nomenclature.

Room A.

President: E. B. Poulton. Vice-President: K. Kertész.
Secretary: K. Jordan.

PAPERS:—

(a) Rev. G. Wheeler and G. T. Bethune-Baker.

"Nomenclature, with a communication from the Entomological Society of London."

(1) Proposal from Entomological Society of London for formation of International and National Committees.

(2) Unofficial suggestions as to desirable restrictions.

(b) M. Ch. Oberthür.

"Pas de bonne Figure à l'appui d'une Description, pas de Nom valable."

(c) To be read on behalf of Mr. L. B. Prout.

"On the place of Figures in descriptive Entomology."

2. Morphology and Anatomy.**Room B.**

President: P. Calvert. Vice-President: J. C. H. de Meijere.
 Secretary: R. S. Bagnall.

PAPERS:—

(a) F. A. Dixey.

"On the Scent-patches of the Pierinæ."

The specialised scales which serve to distribute scent in many species may be either generally scattered over the wing-surface or collected into patches. In the latter case there is a special supply of air tubes to the sockets of the scales.

(b) G. H. Carpenter.

"The Presence of Maxillulæ in Beetle Larvæ."

Demonstrates the presence of paired appendages (maxillulæ) connected with the hypopharynx in certain larvæ of the Coleoptera.

(c) G. Horváth.

"Sur la Construction de l'Élytre des Cicadides."

(d) S. J. Longinos Navás.

"Algunos Órganos de las Alas de los Insectos."

9 p.m.**Room A.**

S. A. Neave.

"Travels of an Entomologist in Eastern Africa."

Wednesday, August 7th.**10 a.m.****GENERAL MEETING.****Room A.**

President: J. H. Comstock. Vice-President: the Hon. W. Rothschild.
 Secretary: H. Eltringham.

PAPERS:—

(a) J. van Bemmelen.

"The Phylogenetic Significance of the Wing-markings of Rhopalocera."

(b) J. W. Taylor.

"Geographical Distribution and Dominance in relation to Evolution and Phylogeny."

The principles governing the laws of Geographical Distribution. Influence of Environment, Phylogeny, etc., and the need of Entomological Investigation on these Lines.

(c) Leonard Doncaster.

"Sex-limited Inheritance in Insects."

An account of the inheritance of characters which show sex-limited transmission in the Moth *Abraxas grossulariata* and the fly *Drosophila ampelophila*.

SECTIONS.

1. Economic and Pathological.

Room B.

President : J. Jablonowski. Vice-President : R. C. L. Perkins.
Secretary : J. C. Moulton.

PAPERS :—

- (a) J. Jablonowski.
"The Destruction of *Stauronotus maroccanus* in Hungary."
- (b) J. Jablonowski.
"On the Destruction of *Cochylis* and *Eudemis* in the Vineyards."
- (c) A. G. L. Rogers.
"The necessary investigation with relation to Insect and Fungus Enemies of Plants, preliminary to Legislation."

2. Systematics and Distribution.

Room A.

President : Capt. Ch. Kerremans. Vice-President : S. J. L. Navás.
Secretary : G. T. Bethune-Baker.

PAPERS : —

- (a) Rev. J. Waterston.
"On a new Scottish Parasite on *Procelluria*."
- (b) A. Dampf.
"Systematik, geographische Verbreitung und Phylogenie der Arten aus der *Hydracia nicittans* Gruppe."

[Withdrawn]

- (c) Miss Huie.
"Notes on the value of adding Acetic Acid to Alcohol in the preservation of Larvæ."

[Withdrawn]

9.0 p.m.

Room A.

- (a) M. Burr and K. Jordan.
"On *Arixenina*, a Suborder of Dermaptera."
- (b) K. Jordan.
"On Viviparity in Polychtenidæ."

Wednesday Afternoon.—Excursions.

- A. YOULBURY, by kind invitation of Sir Arthur Evans, F.R.S. Available for about 50 members. Conveyances will leave the Museum at 3.30, for those members who do not wish to walk. Fare about 2s. 6d.
Withdrawn by the Committee on account of insufficient number of entries.

B. NUNEHAM, by kind invitation of the Rt. Hon. L. V. Harcourt, M.P., Secretary of State for the Colonies. By Steamer, leaving Folly Bridge at 2.30. Return fare, 1s. 6d. Available for about 70 members.

C. BAGLEY WOOD, by kind invitation of the President and Fellows of St. John's College. By Steamer, leaving Folly Bridge at 2.30. Return fare, 1s. Available for about 50 members.

The list of Members joining these Excursions will close on Monday afternoon at 6 o'clock. Entries must be notified at the Secretary's Office before that time.

Thursday, August 8th.

10.0.

GENERAL MEETING.

Room A.

President: E. J. G. Everts. Vice-President: A. Handlirsch.
Secretary: H. Eltringham.

PAPERS:—

(a) A. Handlirsch.

"Ueber einige Beziehungen zwischen Palaeontologie, geographischer Verbreitung und Phylogenie der Insekten."

(b) E. E. Green.

"A Plea for the Centralisation of Diagnostic Descriptions."

SECTIONS.

1. Evolution, Bionomics, and Mimicry.

Room B.

President: The Rev. F. D. Morice. Vice-President: W. M. Wheeler.
Secretary: K. G. Blair.

PAPERS:—

(a) W. C. Crawley and H. St. J. K. Donisthorpe.

"On the founding of Colonies by Queen Ants."

(b) W. M. Wheeler.

"Observations on the Central American Acacia Ants."

2. Morphology and Anatomy..

Room A.

President: E. L. Bouvier. Vice-President: P. Speiser.
Secretary: G. Meade-Waldo.

Chair taken by the Vice-President.

PAPERS:—

(a) Frederick Lowe.

"The Devolution of Wing Structures as shown in *Blattidæ*."

1. Giving the results of practical work, and describing a new method.

2. Giving measurements of the wings of a large series of *Blattidæ*.

(b) Dr. T. A. Chapman.

"Regeneration of the Legs of *Liparis dispar*."

Effects of the parts being lost at different stages and tendency to reduplication of parts.

3. Economic and Pathological.

Room C.

[Adjourned from Wednesday ; officers the same.]

(a) Continuation of discussion on Mr. Rogers's paper.

(b) F. V. Theobald.

"Aphides of the Cultivated Peas, and the allied species of the genus *Macrosiphum*."

2 p.m.

SECTIONS.

1. Nomenclature.

Room A.

President : F. A. Dixey. Vice-President : E. Olivier.

Secretary : K. Jordan.

Chair taken by the Vice-President.

PAPERS :—

(a) W. Horn.

"Protest gegen die Zulassung von Ausnahmen vom Prioritäts-gesetze."

(b) Ch. Kerremans.

"Les Variétés doivent-elles être nommées ?"

Sur la nécessité de restreindre les noms donnés aux variétés, de les remplacer par une lettre ou un No. d'ordre.

(c) Ernest Olivier.

"Nécessité de l'Emploi du Latin pour les Descriptions."

2. Economic and Pathologic.

Room B.

President : G. Hewitt. Vice-President : V. Ferrant.

Secretary : H. Rowland-Brown.

PAPERS :—

(a) Stephen A. Forbes.

"*Simulium* and Pellagra in Illinois, U.S.A."

Results of studies of species, distribution, and life-histories of *Simulium* as related to new cases of Pellagra in asylums.

(b) Frederick A. Lowe.

"How to kill that Fly."

(c) F. W. Ulrich.

"The Biology of some Trinidad Mosquitoes, and notes on their control."

[Withdrawn]

Friday, August 9th.

10 a.m.

SECTIONS.

1. Evolution, Bionomics and Mimicry.

Room A.

President: V. Kellogg. Vice-President: A. Grouvelle.

Secretary: H. H. Druce.

PAPERS:—

- (a) R. C. Punnett, on behalf of Mr. J. C. F. Fryer.
"The Polymorphism of *Papilio polytes*."
- (b) C. F. M. Swynnerton. (Communicated by Prof. Poulton.)
"Pellets ejected by insect-eating Birds after a meal of Butterflies."
- (c) M. Pic. (Communicated.)
"Le mélanisme chez divers *Cryptocephalus* paléarctiques."
- (d) A. H. Hamm.
Exhibition of photographs of insects in resting attitudes in their natural surroundings.

2. Systematics.

Room B.

President: N. Banks. Vice-President: A. v. Schulthess.

Secretary: J. E. Collin.

PAPERS:—

- (a) K. von Rosen.
"Die fossilen Termiten."
- (b) P. Speiser.
"Bemerkungen und Notizen zur geographischen Verbreitung einiger blutsaugenden Insekten."
- (c) P. Speiser.
"Ueber die geographische Variabilität afrikanischer Bombyliden."
- (d) Philip P. Calvert.
"Progress in knowledge of the Odonata from 1895 to 1912."
A statement of the advance of knowledge of the structure, life, development, geographical and geological distribution, habits, classification, and phylogeny of the *Odonata* in the period indicated.
- (e) R. S. Bagnall.
 - (1) The order *Thysanoptera*.
 - (2) The British *Protura*, a primitive and recently diagnosed order of Insects.
 - (3) A synopsis of the family *Æolothripidae* of the order *Thysanoptera*.
 - (4) Exhibition of new British *Thysanura*, *Collembola*, *Thysanoptera*, *Mallophaga*, and *Myriapoda*.
 - (5) Exhibition of the *Thysanoptera* of the Hawaiian Islands.

- (f) E. L. Bouvier. (Communicated.)
 "Sur le stade 'natant' ou 'Puérulus' des Palinurides."

2.0 p.m.

GENERAL MEETING.

Room A.

President: E. B. Poulton. Vice-President: H. J. Kolbe.
 Secretary: M. Burr.

PAPERS:—

- (a) Adalbert Seitz.
 "On the Sense of Vision in Insects."
 Results of biological experiments on the eye, and physiological remarks. Ultraviolet rays, colours, outlines, etc.
- (b) V. L. Kellogg.
 "Distribution and Species-forming among Ectoparasites."
 Discusses the distribution, both geographical and host, of all the known species of *Mallophaga*.

GENERAL BUSINESS.

- (1) Report of the Executive Committee.
 (a) Resolutions on Nomenclature.
 (b) Resolution on International Legislation.
 (c) Election of additional members of the Permanent Committee.
 (d) Election of Honorary Members.
 (e) Selection of place of meeting of the Third Entomological Congress, 1915, and election of President.
- (2) President's Farewell Address.

On Friday evening, a Banquet will be held in the Hall of Wadham College at 7.30 p.m. The price will be 7s. 6d. each, exclusive of wine. Tickets may be had at the office of the General Secretary from Tuesday midday. Members wishing to attend the Banquet must inform the Secretary before midday on Wednesday.

On Saturday, the members of the Congress are invited by the Hon. Walter Rothschild to visit Tring Park and to inspect his Zoological Museum. A special train will leave the London and North Western Station at 8.35 on Saturday morning for Tring. Those members who are returning to Oxford the same day must take return tickets to Tring, which will be issued at the reduced fare of 4s. 8d., provided there are more than ten passengers. These will be available for return by ordinary train leaving Tring at 5.46, changing at Bletchley, and arriving at Oxford at 8.10. Members wishing to proceed to London after the visit to Tring must take tickets from Oxford to London (Euston). These tickets will be issued at the ordinary rate of 5s. 3½d., but passengers will be allowed to break the journey at Tring. A convenient train leaves Tring for London at 4.52. Members deciding to avail themselves of Mr. Rothschild's invitation must notify the Secretary

not later than 6 p.m. on Monday, August 5th, stating at the same time whether they intend to return to Oxford or proceed to London.

By kind permission of the Warden of Wadham a private Café has been installed in the garden of that College. Luncheons, teas, and light refreshments will be provided at moderate prices. Only members and their friends will be admitted.

MONDAY, AUGUST 4TH.

At 9.0 a.m. the Secretaries' office was open for inquiries, and for the distribution of badges, guides, and programmes to those who had not received them on the previous evening.

OPENING MEETING.

At 10.30 the members, to the number of about 150, assembled in Room A, and the Congress was opened by the President, Professor E. B. POULTON, Dr. G. HORVÁTH being Vice-President, and H. ELTRINGHAM Secretary.

PRESIDENT'S INTRODUCTORY ADDRESS.

WITH PLATES I AND II.

It is my pleasure and privilege to bid a hearty welcome to all who are now visiting Oxford for the second International Entomological Congress. Two years ago we met in Brussels for the first, and in every way successful opening meeting of the long series of International Congresses to which we all look forward with confidence. Then the language of our hosts was the beautiful and classic language of France, and at that meeting Frenchmen stood in a special relation to our Belgian hosts. Speaking the same language, they were in a sense, though present as guests, acting as hosts. On this occasion, meeting in Oxford, you are welcomed not only by the entomologists of the British Isles, but also of the British Colonies and of India, and I venture to invite the American members, who speak our language, to act with us as hosts, and to endeavour to make the visit of our continental visitors and colleagues as bright and successful as possible. I know well, from many a happy experience, how gracefully and graciously our American friends play the part of hosts in their own country, and in inviting them to act with us on this occasion

I am sure that I carry with me the feelings and wishes of every British member of the Congress.

I imagine that in the choice of Oxford for the second meeting of the Congress a determining factor was the existence of the Hope Department—the great collection of insects given to the University more than sixty years ago by one of her own sons, and immensely increased by the great name and fame of my distinguished predecessor, Professor J. O. WESTWOOD.

The choice of Oxford gives me the opportunity of expressing gratitude to all those who made the Hope Department—above all to the founders, the Rev. F. W. HOPE and his widow ELLEN HOPE, and to the first Hope Professor, JOHN OBADIAH WESTWOOD. It enables me to acknowledge for him the obligation he had no such great opportunity as this of expressing.

I have brought with me the Visitors' Book of the Hope Department, and in it we see that members of the University first came, on June 12th, 1850, to look at the fine collections, which had just arrived in Oxford. The long list of names shows the immediate interest and attention which were excited in Oxford by the gift of the Rev. F. W. HOPE. The book has received many hundreds of signatures since that date, and preserves a record of the distinguished entomologists who have visited the Hope Collection during sixty-two years; but it is not quite full even now, and I propose to devote the few unoccupied pages to the preservation of the signatures of the members of this Congress. The visitors' book will be placed on a table in the adjoining writing-room, and I hope that every member of the Congress will do me the favour of inscribing his or her name, and thus complete the volume that was begun in 1850.

The Hope Collection was not at first a very large one. In the year 1857 Professor WESTWOOD drew up a detailed inventory in which the contents of 903 cabinet drawers are briefly described: but Mr. Hope was an ideal benefactor, who, for the remainder of his life, never ceased to augment his original gift, buying and adding to it everything of interest to entomological science which he had the chance of acquiring. For about ten years the Hope Collection remained in the Taylorian Building, where it was first accommodated, but it was moved, on the completion of the new University Museum, to a part of the space which it now

occupies. The Hope Professorship of Zoology was established in 1861, and I believe there is little doubt that Mr. HOPE founded it in connection with the migration to the University Museum, a migration contemplated in the original deed drawn up in 1849.

I look back over many years of kindness and most pleasant friendship with my master in Entomology, Professor WESTWOOD—going back to the year 1873, before I became an undergraduate. At that time, as a boy of seventeen, working in the Museum for a scholarship, I often stole an hour from my regular studies in order to visit the Professor and to learn something of the great entomological collection and library. Professor WESTWOOD treated the young beginner with great kindness and sympathy, and I was permitted to learn much of the intimate thoughts of this eminent leader in the science. Thus, I gathered that of all the long list of classical works which WESTWOOD produced, the one to which he looked back with the deepest interest and affection was his wonderful *Introduction to the Modern Classification of Insects*. I remember his telling me with a touch of pride that the book was known in America as “The Entomologist’s Bible.”

Another interesting feature which makes it appropriate that the Congress should meet in this Museum is the relation which the building bears to the history of Darwinian teaching. Just fifty-two years ago, on June 30th, 1860, between seven hundred and a thousand people gathered in the room which lies a few yards away to the west of the lecture-theatre in which you are sitting, in order to listen to a discussion on evolution, with DARWIN’s old teacher, Professor HENSLOW of Cambridge, in the chair. That room, where we shall peacefully write our letters and indulge in quiet talk in the intervals of the more strenuous work in the sections, was the scene of the celebrated duel between the Bishop of Oxford and Professor HUXLEY. Hardly any episode in the history of Darwinism has been more discussed, and probably no other produced so much excitement; yet, as oftentimes when feelings run high, it is very difficult to know what actually happened. Many versions have been published,¹ but I believe that the most accurate account is that given by my

¹ See *Life and Letters of Charles Darwin*, Lond., 1887, vol. ii., pp. 320–323; *Life and Letters of Thomas Henry Huxley*, Lond., 1900, vol. i., pp. 179–189.

friend Dr. A. G. VERNON HARCOURT. It will be remembered that the Bishop of Oxford at the climax of his speech turned to HUXLEY and asked him if he was descended from a monkey on his grandfather's or his grandmother's side. Some of those who were present have said that HUXLEY was so angry that he was really ineffective, while others maintain that he was perfectly calm, and rebuked the Bishop with dignity and complete success. His reply, as it is remembered by Mr. HARCOURT, is precisely the sort of answer we should have expected from Professor HUXLEY.

" . . . if I am asked whether I would choose to be descended from the poor animal of low intelligence and stooping gait, who grins and chatters as we pass, or from a man, endowed with great ability and a splendid position, who should use these gifts " [here, as the point became clear, there was a great outburst of applause, which mostly drowned the end of the sentence] " to discredit and crush humble seekers after truth, I hesitate what answer to make." ¹

My eminent predecessor was well over fifty when *Natural Selection* came before the world in 1858, and *The Origin of Species* in 1859, and it is always exceedingly difficult, generally indeed well-nigh impossible, for a man of that age to mould his ideas afresh. The conspicuous exception was Sir CHARLES LYELL, who, having published his opinions against the new views, finally came late in life to accept them. Such examples must always be very rare, and certainly Professor WESTWOOD was no exception. He remained for the whole of his life strongly opposed to evolutionary teachings ; in fact, he proposed to the last Commission that the University should permanently establish a lectureship for the unceasing refutation of the errors of Darwinism. I well remember being asked by Professor WESTWOOD what I had been reading, and how serious he looked when I told him *The Origin of Species*. He seemed to think that it was an unsuitable book for one so young, and that the authorities of the University and my College had been guilty of some indiscretion in allowing it to come into my hands. Nevertheless, WESTWOOD's relations with CHARLES DARWIN were of the most pleasant description, and he was always proud of the fact that one of the Royal Medals was conferred on him, on the nomination of the Council of the Royal

¹ *Life and Letters of Thomas Henry Huxley*, 1900, vol. i., p. 185.

Society, as the result of the representations of Charles Darwin, who had carefully studied the *Introduction to the Modern Classification of Insects*. More than one letter in Darwin's correspondence deals with this very episode.

Oxford is also specially appropriate for the first meeting of the Congress in this country, because it is the seat of the most ancient University in the British Empire, and because much that is interesting and historic may be learnt in the intervals of the varied and voluminous programme which has been arranged. The Colleges have hospitably opened their doors to members of the Congress, and those who are staying at Wadham, founded in 1612, may remember that they are residing in a College of special interest in relation to the history of science in this country ; for it was at Wadham that the Royal Society may be said to have begun. A party of friends who met in the rooms of Warden WILKINS—rooms still existing unchanged in the house of the present Warden—afterwards continued their meetings in London, thus creating the " Invisible College," which became the Royal Society. Members of the Congress who have rooms in Merton will be living in the earliest of all Collegiate buildings, and one which, founded in 1264 and established in Oxford ten years later, served as the type followed in both our ancient Universities. Members staying at New College may like to remember that the foundation was established as a kind of " new model " by WILLIAM OF WYKEHAM in 1379.

We have especially to thank the Warden of Wadham for his great generosity in lending his private garden to the members for the whole of the week, so that there, close at hand, we can refresh ourselves in the intervals between the meetings, and can sit and talk in the evenings. We may indeed almost fancy ourselves on the Continent, where beautiful surroundings are more commonly put to such uses than in this country, while some of our friends, though still in Oxford, may now and then imagine that they are at home.

It will be our duty at the conclusion of the Congress to thank the many friends who have helped us to prepare for the meeting, but I must even now, at the very beginning, express our thanks to one or two who have taken a special part in the work of organisation. My friend, Dr. F. A. DIXEY, F.R.S., being Bursar of

Wadham, has settled all the details in the arrangements of which I was just now speaking. The General Secretary, Dr. MALCOLM BURR, who has been himself far from well, is unable to be present in consequence of the very serious illness of his wife. We all extend to him our warmest sympathy, and the hope that Mrs. BURR will rapidly recover, and that he himself will soon be restored to full health and strength. In the meantime Mr. H. ELTRINGHAM, although he has only just brought out a long and exhaustive monograph on the *Acræinæ*, occupying the whole of Part I of the *Transactions of the Entomological Society of London* for this year, has thrown himself into the breach, and, with the assistance of Mr. G. H. GROSVENOR, has enabled us to overcome all the difficulties which threatened to overwhelm our preparations for the meeting.

I must also refer to the friendly and cordial relationship between the University Museum and the two great Museums established near Oxford, the British Museum of Natural History and the great Zoological Museum at Tring. From these two Museums the Hope Department has always received the kindest help, and I am glad to think that we in turn have been able to render them some assistance. We shall have the opportunity on Saturday of visiting the Tring Museum, and I am sure that we all look forward with very great pleasure to that day as a most agreeable and appropriate close to the Congress of 1912.

I propose to devote the remainder of this address to the exhibition and description of the series of the African Swallow-tail butterfly, *Papilio dardanus*, and the related island forms in the University collection. By this single great example I hope to make clear one chief aim of the Hope Department—the study of specific change in relation to geographical distribution and to the organic environment. Members of the Congress who desire to study in detail the work which has been done will have ample opportunity of seeing two great collections—the *Pierinæ* worked out and arranged by Dr. F. A. Dixey, the *Acræinæ* by Mr. H. ELTRINGHAM—as well as the special series, illustrating mimicry and other bionomic principles, in which both the *Pierinæ* and *Acræinæ* play an important part.

The complexity of the problem presented by *Papilio dardanus*

is sufficiently indicated in the accompanying Plate I, which represents the male (Fig. 1) and four mimetic female forms (Figs. 7 to 10), together with their respective Danaine models (Figs. 2 to 5) from the same geographical area—Natal. Before 1869, when ROLAND TRIMEN'S classical memoir¹ appeared, three of these mimetic females were held to be three different species, and the male a fourth. Figs. 1, 7, 8, 9, and 10 on Plate I are of special interest in that they represent individuals from one of the families bred from a known female parent (Fig. 6), which have put the final coping-stone on the proof brought forward by the great African naturalist and ably defended by him against the fierce attacks of the older systematists.²

I think that you will best see what we have been able to do in working out the wonderful history of *Papilio dardanus*, if I arrange in the frame behind the lecture-table the twenty-seven drawers that are now piled before you, giving them such relative positions as will approximately indicate the geographical distribution.

We begin with the ancestral non-mimetic island form confined to Madagascar, *Papilio meriones* (Plate II, Figs. 1, 2). It will be observed that the non-mimetic female differs from the male in the presence of a black mark curving into the forewing cell from the basal half of the costa. This mark is of the greatest importance, for it serves as the starting-point for the mimetic patterns of the continental females (cf. Fig. 2 with 6, 7, and 8 of Plate II). A somewhat similar non-mimetic form, which we do not possess, *P. humbloti*, is found in the Comoro Islands.

We now enter the Ethiopian region—Africa south of the Sahara—at its north-east corner, and here in Abyssinia and Somaliland we find another non-mimetic subspecies, and the only continental one, namely *P. antinorii*, which I next place upon the frame. I have called this subspecies non-mimetic, but as a matter of fact two single mimetic females of different forms have been obtained in Abyssinia. Neither of them has appeared a second time, and they are in themselves so very remarkable, combining the fully formed "tails" of the male butterfly with two highly developed mimetic female patterns,

¹ *Trans. Linn. Soc., Lond.*, vol. xxvi., 1870; Pt. III., 1869, p. 497.

² See especially *Trans. Ent. Soc., Lond.*, 1874, pp. 139-141.

that until further evidence is forthcoming one is tempted to regard them as hybrids between a wandering male from further south, carrying tendencies of the mimetic females, and the ordinary female of *antinorii*. Omitting these from consideration until further specimens have been obtained, the *antinorii* male and female are closely similar to the Madagascar *meriones*, except for a considerable reduction of black on both the wings of both sexes. The female still presents the black mark on the costa which is the beginning of the mimetic pattern.

I next place upon the frame the most interesting of all the subspecies, namely *polytrophus*, from the lofty eastern edge of the great Rift Valley, near Nairobi in British East Africa (Plate II, Figs. 3 to 9). Here, on the Kikuyu Escarpment, at an elevation of 6,500 to 9,000 ft., we meet with all the mimetic forms of the female *dardanus*, together with innumerable intermediates and an abundant ancestral form, *trimeni*, which has not entirely lost the yellow ground-colour of the male and non-mimetic female, and shows a prolongation of the costal mark towards the posterior angle of the forewing, giving in different individuals every transition between a marking well-nigh as rudimentary as that of the *meriones* female itself, and the fully formed bar of *hippocoön* (cf. Figs. 2, 6, 7, and 8 on Plate II). It is characteristic of the ancestral *trimeni* females that they are exceedingly variable, and especially so in the degree of development of the bar crossing the forewing. They further commonly exhibit a vestigial trace of the "tail" to the hindwing (Figs. 6 and 9). Comparison between Figs. 6, 7, and 8 shows that the fully formed mimetic female *hippocoön*, resembling in East Africa the Danaine model *Amauris niavius dominicanus* (Plate I, Fig. 2), has been derived from *trimeni* by the transformation of the yellowish ground-colour into white, and the sharpening of the outlines of the most fully developed black pattern. Comparison with Fig. 9 shows that the *trophonius* form, mimetic of *Danaida chrysippus* (Plate I, Fig. 3) over the whole Ethiopian region, is derived directly from *trimeni* by a fulvous flush overspreading the principal pale area extending over a large part of both wings. In the interesting example represented in Fig. 9 the flush does not cover the whole of this area, and the uncovered part, as well as all the other pale markings, are of the yellowish

tint of *trimeni*. A slight trace of the "tail" is also to be seen in the same specimen. The most specialised of all the mimetic females, *cenea*, mimetic of *Amauris echeria* (Plate I, Fig. 5) and *Am. albimaculata* (Plate I, Fig. 4) in East Africa, and westward as far as the Eastern borders of the Congo State, also appears to have been directly derived from *trimeni*. Thus Fig. 4 on Plate II shows us an example with the fully developed *cenea* pattern, but with all the pale markings retaining the yellowish tint of *trimeni*. Comparison between Figs. 4 and 6 shows that the hindwing of *cenea* is easily derived from *trimeni* by an increase in the breadth of the black border, while the forewing also originated by an increase of black, together with the splitting up of the pale markings into a series of separate spots. The traces of such a process can, in fact, be seen in an initial stage in the outer half of the forewing of the *trimeni* represented in Fig. 6. Comparison between Figs. 4 and 5 shows how the ordinary colours of *cenea* are obtained by a darkening into ochreous of the basal part of the hindwing, while all the other markings become white or sometimes ochreous, according as the form mimics varieties of *Amauris* with white spots or with yellow spots in the forewing. The wonderful mimetic form *planemoides*, resembling the male of *Planema macarista* and both sexes of *Pl. poggei*, is also found among the remarkable assemblage of female forms on the Escarpment, although, if either of its models occurs at all in this locality, it must be extremely rare. The *planemoides* female almost certainly arose in connection with the origin of the *cenea* form: the hindwing, in fact, is almost precisely *cenea*'s, except that the basal patch becomes white like *hippocoön* instead of ochreous like *cenea*. In the forewing the pale markings of *trimeni* are not so completely broken up into separate spots as in the origin of *cenea*, but form larger areas which gain a rich fulvous tint and fuse together into a band crossing the wing from the costa to the posterior angle. It is exceedingly interesting to find that an ancestral stage in the development of this pattern is to be found, not only in association with the fully formed *planemoides*, but also in Natal, far south of the range of the *Planema* models. This ancestral stage of *planemoides*—the *leighi* form—indicates very clearly the way in which the forewing band of *planemoides* arose

from *trimeni*. We find, in fact, a forewing pattern which is in part that of *cenca* and in part that of *hippocoön*, but with all the markings transformed into fulvous orange. Intermediate stages between *leighi* and *planemoides* are also found both within the range of *planemoides* itself and also some hundreds of miles eastward of it and its models (see p. 33).

The *polytrophus* females have occupied a good deal of our time and attention, but they are of extraordinary interest as showing us the origin of all the mimetic forms of the species. The pattern of the male *polytrophus* (Plate II, Fig. 3) bears considerable resemblance to the western subspecies *dardanus dardanus*, but there is, I think, little doubt that *polytrophus* is in interbreeding connection not only with *dardanus dardanus* on the west, but with *dardanus tibullus* on the east. In the forest at a lower elevation (about 5,500 ft.), near Nairobi itself, we meet with a larger form of male bearing heavier markings. At this elevation *trimeni* is still to be seen—a fine example, captured by the Rev. K. ST. AUBYN ROGERS, is in the drawer I have just placed upon the frame, with another remarkable form, apparently a mimic of *Danaida chrysippus* f. *dorippus*, captured in 1903 by the late Mr. C. F. ELLIOTT.¹ There can be no reasonable doubt that these larger specimens of the lower slopes form one interbreeding community with those of the higher, and that *tibullus* on the east is syngamic with *polytrophus* of the lofty Escarpment near Nairobi.

Before leaving *polytrophus* I ought to mention that the remarkable ancestral form *trimeni* appears to belong chiefly to the East African section of the *dardanus* subspecies; for it is not only common at Nairobi, but the first specimen to reach a European collection was captured in 1884 by Lieutenant TURNER well within the area of *tibullus* at Zanzibar.² Varieties which I think are to be interpreted as forms of the variable *trimeni* have been described by AURIVILLIUS from Kibara, to the west of

¹ *Trans. Ent. Soc., Lond.*, 1908, pp. 554-7. The date of capture is erroneously given as "1893" on p. 556. A coloured figure of the specimen may be seen in ELTRINGHAM'S *African Mimetic Butterflies*, Oxford, 1910, Pl. X, Fig. 11. Excellent coloured representations of nearly every form of *P. dardanus* are given on the same plate.

² *Proc. Ent. Soc., Lond.*, 1897, pp. lxxxviii, lxxxix; *Trans. Ent. Soc.*, 1906, p. 283, Pl. XIX, Fig. 1.

Lake Mweru, and Ukerewe Island in the south of the Victoria Nyanza.¹ On the west coast, *trimeni* appears to be represented by another ancestral form, the relatively rare *dionysus*, which will be considered later.

The next four drawers now placed in the frame represent forms of the subspecies *dardanus dardanus* from Kisumu (Port Florence), the inland terminus of the Uganda Railway on the north-east shore of the Victoria Nyanza, from the northern and north-western shores as far as the Anglo-German boundary. The males of this subspecies, which extends to the west coast, approach, in the relative amount of black marking, those of *polytrophus* on the high Escarpment and the Madagascar *meriones*. The females resemble Danaïne and Acræine models of their locality, and here too, in the eastern part of the range of the western subspecies, all the mimetic female forms are represented. The commonest is *hippocoön*, and next *planemoides*, while *trophonius* and *cenea* are both relatively rare.² The white sub-apical bar of *trophonius* is often transformed into fulvous (the *niobe* form) in mimicry of *Planema tellus*, and in a

¹ Arkiv f. Zool., K. Svenska Vetenskapsakad., Stockholm, Bd. 3, No. 23, 1907.

² The corresponding female forms of the various subspecies of *P. dardanus* were called by the same names in the address, notwithstanding the fact that there are slight differences between them. Such differences seem to be sufficiently indicated by prefixing the subspecific name. I wrote upon this point in 1906: "The name *hippocoönoides* has been given by HAASE to this form [*hippocoön*] in the eastern and southern subspecies *tibullus* and *cenea*. This seems to me a most unnecessarily complex and inconvenient procedure. The *trophonius* of the western subspecies [named *trophonissa* (1907) by AURIVILLIUS] *merope* [*dardanus*] is at least as different from that of the southern *cenea* as are the two forms of *hippocoön* from the same areas. It is pretty certain indeed that each female form of every subspecies has certain peculiarities and is not exactly like the same form of any other subspecies. But this is quite sufficiently indicated by prefixing to the female form name the subspecific name. *Papilio dardanus* subspecies *merope* ♀ f. *hippocoön* of the west coast is naturally different from *P. dardanus* subspecies *cenea* ♀ f. *hippocoön* from Natal, and it is quite unnecessary to express this by turning the last name into *hippocoönoides*. To do so without making corresponding changes in the other forms is inconsistent; to be consistent in this respect is immensely to increase and to increase uselessly an already tremendous terminology." *Trans. Ent. Soc., Lond.*, 1906, p. 289.

fine variety from Entebbe presented by Mr. H. ELTRINGHAM it will be seen that the bar is fused with the principal fulvous marking. *Papilio dardanus* has not as yet been bred either at Nairobi or in Uganda,¹ and this final proof that *planemoides* belongs to the *dardanus* association is still wanting. Nevertheless, a single specimen now before you constitutes in itself conclusive evidence that *planemoides* has been rightly placed. This specimen was collected by Captain T. T. BEHRENS in Buddu (1902-3), and it is gynandromorphic on the left side, the yellow scales and part of the dark markings of the male *dardanus* being dovetailed into the pattern of the female *planemoides*.² It is quite certain that such an intermixture of characteristics can only occur between the male and female of the same species, and that therefore *planemoides* is one of the female forms of *dardanus*.

It is interesting to consider the probable causes of the relative rarity of the mimetic female forms in Uganda; *hippocoon* mimics *Amauris niavius*, the most conspicuous Danaine, and probably the most conspicuous butterfly of the African forests; *planemoides* mimics the highly conspicuous pattern of the male *Planema macarista* and both male and female *Pl. poggei*; *trophonius* mimics the ubiquitous *Danaida chrysippus*, but this is an open country and woodland butterfly, not a forest species like its mimic, and the two would only be commonly associated along the borders of their respective stations. This relationship almost certainly accounts for the fact that, although *trophonius* occurs in all the subspecies of *dardanus* with mimetic females, it is nevertheless invariably a rare form. *Cenea* mimics *Amauris echeria*, which is excessively abundant in Uganda, the rarer

¹ Since this address was delivered, Dr. G. D. H. CARPENTER has succeeded in obtaining 26 eggs from a *planemoides* female on Bugalla, one of the Sesse Islands, in the north-west of the Victoria Nyanza. He kindly wrote to me early in the course of the breeding experiment, and, as I happened to be publishing an article on *P. dardanus* at that time (*Bedrock*, April 1913, p. 42), I alluded to his investigations in the following words: "We may anticipate that the offspring will be chiefly or entirely *planemoides* and *hippocoon*." On the very day when I was correcting the proofs (March 7th, 1913), I received another letter telling me the results, namely 3 *planemoides*, 7 *hippocoon* and 12 males (l.c., p. 47 n.). The whole family is now in the Hope Department. See *Proc. Ent. Soc., Lond.*, 1913, pp. xxxiii-xxxv, also for June 4th.

² *Trans. Ent. Soc., Lond.*, 1906, p. 297, Pl. XVIII, Fig. 4.

Am. albimaculata, and the relatively very rare *Am. grogani*. These butterflies, however, although as a whole a very important element in the Danaine fauna, have not the conspicuous pattern of *Am. niavius*, and it is to be observed here, as in other parts of Africa, that when these two Danaine patterns exist side by side the more conspicuous one exerts a far more powerful influence upon the mimetic forms of *dardanus*, even when the model which bears it is not nearly so abundant as the others (cf. p. 34).

We pass to the tropical west coast represented in the seven drawers now placed in the frame. The northern section is marked by the excessive predominance of *hippocoön*, corresponding with the fact that, of the series of models mentioned in the preceding paragraph, only *niavius* and *chrysippus* exist in this part of the range. Furthermore, *chrysippus* is represented by the tropical west coast form *alcippus*, with white hindwings, and is therefore even less suitable than in other parts of Africa as a model for *dardanus*. Along the whole of the tropical west coast the strange ancestral form *dionysus* occurs in relatively small numbers. This female possesses a primitive forewing pattern much like that of *trimeni*, but it has entirely lost the yellow ground-colour of the male, being white-marked like *hippocoön*. The hindwing is yellow, resembling, but paler than, that of the western *trophonius*. The forewing pattern exhibits, like *trimeni*, great variation in the development of the black bar which originates the mimetic pattern. In some individuals it is even more rudimentary, and therefore more like the Madagascar female, than in any *trimeni* that I have seen.

We may feel confident that the results of breeding from a female form in any locality may be fairly accurately predicted by looking to the relative proportions of female forms which there exist. For this reason I anticipated that the great majority of families bred in the northern section of the west coast would yield *hippocoön* and nothing else. Owing to the kindness of Mr. W. A. LAMBORN I have fortunately been able to test this conclusion, and the drawers before you contain three families bred by him from *hippocoön* females, in the Lagos district. These families contain respectively 14, 13, and 10 females, and all are of the *hippocoön* form.¹

¹ *Proc. Ent. Soc., Lond.*, 1912, pp. xii-xvii. Since the address was

It is of importance to note that the pattern varies somewhat in the different families, the first showing an evident tendency towards the enlargement of the principal white patch which spreads over part of both wings. The *hippocoon* form of the east coast differs from that of the west in the increased size of this patch, corresponding with the difference between the eastern *Amauris niavius dominicanus* and the western *Amauris niavius niavius*. It is therefore of much interest to find on the west coast a hereditary tendency towards slight changes in the size of the patch. It is reasonable to suppose that by selection operating upon such small hereditary differences the eastern *hippocoon* could be derived from the western, and *vice versa*.

In the southern section of the tropical west coast the female forms become more varied, and we again meet with *planemoides*, doubtless continuous, across the great tropical forest, with the assemblage of the same forms in Uganda, and corresponding with the co-existence of the appropriate *Planema* models over the whole area. The single specimen before you from Angola is of interest as being probably the first example in any European collection. It was collected in 1873 by W. ROGERS.¹ The relatively frequent occurrence of *niobe* also probably corresponds with the presence of its *Planema* model.

We now return to Nairobi, the central point of the great

delivered Mr. LAMBORN has bred three more families, containing respectively 14, 7, and 6 females, all *hippocoon*. He also obtained a few eggs from a *dionysus* form, but unfortunately these failed to hatch. I suggested to Mr. LAMBORN that it would be of great interest to ascertain the effect of artificial cold during the pupal stage of the female forms. In his locality, Oni, seventy miles east of Lagos, it was impossible to keep up a continual supply of ice, but the first of the families mentioned in this footnote was exposed for a few days to a temperature (about 50° F.) which for that part of the world would be unusually low, and it was interesting to observe that 4 out of 14 of the females possessed slight but distinct traces of the "tail" of the male hindwing. Of the other five families only one included females with traces of the "tail"—two similar to the ♀♀ mentioned above and two others with slighter indications. Hence it is not unlikely that an effect was produced by the artificial cold. It is to be hoped that this experiment may be repeated in a locality more favourably placed for the maintenance of a low temperature. See *Proc. Ent. Soc.*, 1912, pp. cxxxi–cxxxiv.

¹ *Proc. Ent. Soc., Lond.*, 1903, pp. xxxix–xli.

series of *dardanus* forms, and place in the frame the drawers representing the subspecies *tibullus*, which extends from the Escarpment to the east coast and spreads southwards till it insensibly passes into the south-eastern and southern subspecies *cenea*. The male *tibullus* is characterised by heavy black markings, especially on the hindwing. It may be interesting to those who look on climatic conditions as the causes of variation to note that the *hippocoön* form of the east coast, with its drier climate, shows a reduction in the black markings as compared with the same mimetic form on the moister west coast, but that the males, on the contrary, are far more heavily marked with black on the east coast than on the west ! If therefore climatic conditions are of any avail in the production of these patterns, it is obvious they have wrought opposite effects on the two sexes of *dardanus*.

It is interesting to pause for a moment and compare the development of the black markings of the male subspecies of *dardanus*. These markings are least developed in the north-eastern *antinorii*, moderately developed and to much the same extent in the Madagascar *meriones*, the Nairobi *polytrophus* and the western *dardanus*, by far the heaviest in the Eastern *tibullus*. As we pass southward into *cenea* the markings again become less heavy, in some individuals indeed approaching those of the west-coast males. Nevertheless, as a whole, *cenea* is more heavily marked with black than any other subspecies except *tibullus*.

The first two drawers exhibit *tibullus* from Nairobi to the British East African coast, and southward into German East Africa. *Hippocoön* is still seen to be by far the commonest form. The single *trimeni* from Zanzibar, already referred to (see p. 28), is to be found in one of the drawers. *Trophonius* and *cenea* are both present, in correspondence with their models, while the second drawer contains the single remarkable *planemoides* from the Mombasa district (see p. 28).

The next two drawers now placed in the frame represent an exceedingly fine collection from a little patch of primitive forest on Mount Chirinda (3,800 ft.) in S.E. Rhodesia, close to the Portuguese border, a tract of country formerly known as Gazaland. From this locality, owing to the kindness of my friends

Mr. GUY A. K. MARSHALL and Mr. C. F. M. SWYNNERTON, I am able to show the great series now before you. The whole of the females are seen to be *hippocoön*, but *cenea* and *trophonius* also occur, although they are relatively rare. The Oxford University Collection possesses two of each, but these are kept in the special mimicry series, together with their models from the same patch of forest. It is interesting to notice that the Chirinda Danaine models of *cenea*, namely *Amauris albimaculata* and *Am. lobengula*, are together far commoner than *Am. niavius dominicanus*, the model of *hippocoön*, but that nevertheless the latter Danaine, with its far more conspicuous appearance, has produced a much stronger effect on the mimetic female forms of *dardanus* (see p. 31). Turning to the males, it will be seen that the series from Chirinda is intermediate between the more heavily marked *tibullus* of the north and the less heavily marked *cenea* of the south. There is great individual variation, and some of the males would be placed in one category, some in the other.

We now come to the subspecies *cenea*, from Cape Colony and Natal. The specimens in the first drawer are of historic interest in that they provided the first evidence obtained by breeding, but not from a known female parent, that the Protean forms of *dardanus* belong to a single species. The drawer contains two *trophonius* and two *cenea* females bred in 1873-4, near King William's Town, in the south-east of Cape Colony, by the late J. P. MANSEL WEALE¹; also one *trophonius*, one *hippocoön*, two *cenea*, and one intermediate form collected by the same naturalist in 1870-4. These specimens, purchased for the University Collection in 1878, undoubtedly convinced Professor WESTWOOD that ROLAND TRIMEN's conclusions were perfectly sound. I well remember being shown these very specimens by WESTWOOD, and the enthusiasm with which he explained that in the Madagascar representative of *P. merope*, as *dardanus* was then called, the female resembled the male, while the continental females appeared with all kinds of patterns widely different from each other and even more widely different from their own male. I am glad to make this fact known, and to be able to show that, a few years after the following passage was published by ROLAND TRIMEN, my

¹ *Trans. Ent. Soc., Lond.*, 1877, p. 269.

great predecessor had not only ceased to be an opponent, but was teaching the very conclusions he had at first disbelieved.

"Among the lepidopterists with whom I have the pleasure to be acquainted, I think the most uncompromising opponent of my view of this matter was my friend Mr. HEWITSON;—though I must say that our distinguished President, Professor WESTWOOD, was almost as resolute in his unbelief. I am not aware that the latter published anything on the subject. . . ." ¹

The following drawer contains specimens of *cenea* from Natal, where the same female forms as those of Cape Colony are found, together with the peculiar ancestral form *leighi*.

The last series of drawers I have the pleasure of showing you contains the fine synepigonic groups which I owe to the energy and ability of G. F. LEIGH, F.E.S., of Durban. All these have been bred by Mr. LEIGH from females captured at Durban, or in the Durban district.

The first two families were bred from *hippocoön* females, and they show an extraordinary contrast. The first,² bred in 1906, contains 14 males, and the following females—3 *hippocoön*, 3 *trophonius*, 3 *cenea* with white, 5 with more or less yellow marks on the forewing. The parent of this family, together with one of its male offspring, and each of the four female forms with its Danaine model, is represented in the accompanying Plate I. The second family,³ bred in 1907, contains 16 males, while of the 13 females all are *cenea*, and not a single one like the parent.

We now pass to families bred from *trophonius* parents, of which there are 3. The first,⁴ bred in 1903, contains only 3 males, and 2 *cenea* females. The second,⁵ bred in 1904, from a *trophonius* parent which unfortunately escaped, contains 6 males, 1 *trophonius*, and 5 *cenea*. It is interesting to note that the rich fulvous colouring of the *trophonius* parent has produced a distinct effect upon the hindwing patch of one of the *cenea* offspring. The third family,⁶ bred in 1910, is both large and remarkable,

¹ TRIMEN in *Trans. Ent. Soc., Lond.*, 1874, p. 139.

² *Trans. Ent. Soc., Lond.*, 1908, p. 434, Pl. XXIII.

³ *Ibid.*, p. 442.

⁴ *Ibid.*, 1904, p. 685, Pl. XXXI, Figs. 9-14.

⁵ *Ibid.*, 1906, p. 281, Pl. XVII.

⁶ *Proc. Ent. Soc., Lond.*, 1911, p. xxxiii.

containing 25 males, 2 *hippocoön*, 4 *trophonius*, 2 *leighi*, and 22 *cenea*, of which 5 show strongly the effect of the parental colouring. The collection also contains the *trophonius* parent,¹ but not the offspring, of another family bred in 1912 by G. F. LEIGH. The family contained 11 males, 2 *hippocoön*, 4 *trophonius*, 1 *leighi*, and 9 *cenea*.

The last two synepigonic groups were the offspring of *cenea* females. The first² was bred in 1902 from a *cenea* female captured *in copulâ*, so that of this family—7 males, 2 *hippocoön*, and 6 *cenea*—both parents are present. The second family,³ bred in 1907, contains 15 males, 1 *hippocoön*, and 16 *cenea*. In this last family the forewing spots of the *cenea* offspring are somewhat unusually developed—a feature evidently inherited from the female parent. It is also noteworthy that the depth of the black markings of the male varies greatly in the different families described above, and it seems quite clear that the extent to which this characteristic is developed is also hereditary.⁴

I trust that the series of specimens now before you conveys some idea of the spirit in which we try to carry on our work.

I conclude, as I began, by bidding you a hearty welcome, and by expressing the hope that you will always look back with pleasure upon the week you are about to spend in Oxford.

Mr. ELTRINGHAM announced that owing to the unfortunate absence of the General Secretary, Dr. MALCOLM BURR, the Secretary's report could not be given.

The President then announced the arrangement of the sections and called on the Hon. N. CHARLES ROTHSCHILD to give his paper entitled :

NATURE RESERVES.

Hon. N. CHARLES ROTHSCHILD said that the rapid advance of civilisation rendered it urgently necessary to create reserves, where the indigenous fauna and flora might flourish unmolested. He explained the steps which had been taken in Great Britain to achieve this purpose. A Society had recently been formed

¹ *Proc. Ent. Soc., Lond.*, 1912, p. cxxxv.

² *Trans. Ent. Soc., Lond.*, 1904, p. 679, Pl. XXXI, Figs. 1-8.

³ *Trans. Ent. Soc., Lond.*, 1908, pp. 337-441, 443-445, Pl. XXIV.

⁴ *Ibid.*, pp. 429 and 443.

with the object of acquiring suitable tracts of land, and he invited all entomologists to support this movement, with the aims of which every true naturalist must be at one.

Discussion.

Hon. WALTER ROTHSCHILD.—An instance of the necessity of Nature Reserves in the interest of insects was the example of *Parnassius apollo* in Germany. It was a favourite object as a model for drawing lessons, and in consequence the few German localities were actually harried and scoured in the interest of dealers, and the species would soon be exterminated.

Rev. F. D. MORICE.—The recent spread of golf and motoring was destroying many old famous entomological "localities." Hence whatever was to be done should be done speedily.

L. O. HOWARD, having been invited by the President to say a few words on behalf of the United States, said that in the United States the Government had set aside very large areas for forest reserves, and had also protected many regions of scenic beauty. Recently, moreover, the policy had been adopted of establishing reserves for the birds and mammals. No attempt had as yet been made to allow insects an undisturbed existence, in fact governmental activities had all been devoted to the destruction of insect life as an economic problem. As to the inroads of civilisation upon the haunts of insects, he said that one of the most interesting entomological studies of to-day was that of the change of insect fauna, brought about by civilisation and its concomitants. Referring to Mr. MORICE's remark about golf-links, he said that a study of the flora and fauna of golf-links had never been made, but that doubtless most interesting adaptations to novel conditions were taking place amongst the grasses and other plants which survived the constant cutting and tramping, and that doubtless many species of insects were adapting themselves to this novel environment. Just how they were doing this he proposed as an interesting field for study. As a golf player, he did not consider the game as devoid of entomological interest.

E. OLIVIER.—Dans les forêts du Centre de la France tous les grands arbres qui meurent sont actuellement enlevés immédiate-

ment par l'administration, et on ne peut plus trouver toute une série d'intéressants insectes xylophages que l'on captivait en nombre autrefois alors que les arbres morts demeuraient longtemps en forêt avant d'être exploités.

F. WICHGRAF.—Zivilisation ist nicht immer schädlich für die Insektensfauna, manchmal trägt sie zur Verbreitung der Insekten bei. So hat die Eisenbahn die Mosquitos von Delagoa Bai nach Johannesburg gebracht, wo sie vorher nicht existierten.

CH. KERREMANS.—La question soulevée par Mr. ROTHSCILD est du plus haut intérêt. Elle existe en Belgique sous le nom de "mouvement pour la protection de la nature," non seulement en point de vue artistique, mais aussi à celui de la faune et de la flore. Il faudrait que dans tous les pays l'opinion publique se fasse entendre pour réserver à une partie du territoire son intégralité et lui conserver son caractère.

Y. SJÖSTEDT.—Die Frage des Schutzes für seltne oder sonst besonders interessante Tiere hat schon seit lange grosses Interesse in Schweden erregt. Die Akademie der Wissenschaften hat ein permanentes Komitee eingesetzt, dass sich speziell mit dieser und ähnlichen Fragen beschäftigt. Nicht nur ist ein grösseres Gebiet im nördlichsten Schweden, in Lappland, reserviert, in dem weder Tiere (einschliesslich Insekten) gesammelt noch sonst getötet werden dürfen, sondern auch in mehreren andern Distrikten Schwedens sind kleinere, in zoologischer oder botanischer Hinsicht interessante Lokalitäten in erwähnter Beziehung geschützt.

P. SPEISER.—Wir haben in Deutschland eine Anzahl Reservate, bei deren Auswahl aber auf die botanischen Merkwürdigkeiten und die höhern Tiere mehr als auf die Insekten geachtet wird. Es muss und sollte deswegen die Aufgabe der Entomologischen Kongresse sein, die Presse und die Regierungen aufzuklären und sie hinzuweisen auf die wissenschaftliche Bedeutung des Vorkommens eines bekannten Insekts an einem bestimmten Orte, um somit dessen Schutz zu bewirken.

H. J. KOLBE bemerkt in Anschluss an die Mitteilungen von Dr. SPEISER, dass mehrere Reservate in Deutschland eingerichtet werden, und dass es gut ist, dass die Flora konserviert wird. Es ist dabei erfreulich, dass infolgedessen auch die Insekten dieser Reservate geschützt werden. In erster Linie ist bei den

Reservaten an die Flora gedacht (alte Bäume, seltene Blumen) ; aber indirekt erfreut sich die ganze Natur dieser Reservate des Schutzes. Wir Entomologen begrüßen daher die Einrichtung der Reservate mit Freuden.

The meeting then rose.

A meeting of Presidents and Secretaries was then held, when the President explained the procedure to be adopted at the meetings of the sections.

MONDAY, AUGUST 5TH, 2 P.M.

SECTION I.—ECONOMIC AND PATHOLOGICAL.

President: L. O. HOWARD.

Vice-President: R. NEWSTEAD.

Secretary: H. SCOTT.

On taking the chair, L. O. HOWARD said that when he entered the room he was surprised to find that nearly every seat was taken, whereas in a strictly Entomological Congress he would have supposed that other sections would have been more attractive. This indicated to him very strongly the rapidly growing interest in Economic Entomology, and the further fact that the excellent work done by the economic workers in the past few years had appealed even to those engaged in pure science. He recalled the fact that only a few years ago morphologists and systematists hardly considered the economic workers as scientific men at all, and he congratulated the economists in the change of sentiments which their sound work had brought about.

The President then called upon Sir DANIEL MORRIS to read the first paper.

On behalf of Mr. W. A. BALLOU, Sir DANIEL MORRIS read a paper entitled:

SOME ENTOMOLOGICAL PROBLEMS IN THE W. INDIES.

Consideration of the entomological problems presented in W. Indies since 1899. The sugar cane pest, *Phytalus smithi*. Root-boring larvæ. Termites in sugar cane in St. Kitts. Various cotton pests considered. Certain pests controlled by their natural enemies. *Polistes annularis* as a control of the cotton worm (*Alabama argillacea* Hübn.) (cf. Vol. II., p. 306).

Discussion.

G. A. K. MARSHALL stated that he had visited the W. Indies during the past winter in order to interest the local Governments in the furtherance of a central organisation formed by the Colonial Office, the Entomological Research Committee, for the encouragement of the study of injurious insects in the British Colonies. He gave some account of his observations on the sugar cane chafer, *Phytalus smithi*, in Barbados, which had led to the discovery by Mr. NOWELL that the species was being controlled in that island by *Tiphia parallela*, a Scollid wasp. This discovery had been communicated to the Government of Mauritius, where the chafer had been doing very great damage to sugar, and it was hoped that it might be possible to introduce the parasite into that island. Mr. MARSHALL referred to Mr. BALLOU's statement that the *Phytalus* might be either indigenous in Barbados or introduced, and stated that the evidence available made it practically certain that the species was indigenous in the W. Indies, and had been introduced from there into Mauritius.

R. NEWSTEAD commented on the control of certain pests mentioned by the author, and laid emphasis upon the fact that it seemed quite evident that fungi thrived best in a damp, humid atmosphere, rather than in a dry one. In reference to *Eriophyes* he asked whether sulphur in any form had been tried as a remedy.

A. T. GILLANDERS said that as regards parasites the Board of Agriculture in this country had been experimenting with an insect which was doing much damage to the larch crop, viz. *Nematus erichsoni*. They had gathered the cocoons, killed off the perfect insects, and let the parasite, *Mesolius aulicus*, out in the infested area. This had the effect of reducing the pest to some extent. Personally, however, he believed that better cultural methods would do much to eradicate the pest. The larch is a tree which, in consequence of its very light foliage, gives very little shade to the ground. Thus when grown as a full crop the surface conditions of grass and moss were ideal for the breeding of the insect, whereas if the crop were mixed with beech or other shade-bearing trees, the surface conditions accruing from this mixture would be such that the insect could not pass through the pupal stage.

C. J. GAHAN expressed agreement with the opinion of Mr. GUY MARSHALL in regard to the native place of *Phytalus smithi*. The genus was undoubtedly American, and the species probably native to Barbados. The discovery of natural parasites of the species in Barbados was extremely interesting. There was now an opportunity of introducing the parasites into Mauritius, and putting to the test the value of natural enemies in controlling the pest.

The President in the course of some remarks mentioned that in the island of Porto Rico a Planters' Association had been formed on similar lines to the Hawaiian Sugar Planters' Association, and referred to the possibility of natural enemies being introduced into the island, the United States, and the British W. Indies, to control certain pests.

Rev. F. D. MORICE alluded to the remarks just made by Mr. GILLANDERS on the ravages of *Nematus erichsoni*, and mentioned the curious fact that this insect was almost unknown to British systematists, and hardly to be found in museums at a time when the Board of Agriculture was extremely exercised about its ravages, and economic entomologists were seeking means of extirpating it.

H. OSBORN said that it might be of interest in this connection to call attention to an unusual migration of the cotton worm moth, *Alabama argillacea*, from the southern cotton states of the United States to northern states where cotton is unknown. This extended to the great lakes, and in the fruit districts of Lake Erie the peach crop was injured by the moth puncturing the fruit and sucking the juices. In the matter of fungous diseases, extensive experiments with a fungous disease of the chinch bug have shown that it cannot be recommended as a certain control of that pest.

F. V. THEOBALD said that parasites (Chalcids) of the currant Aphis, *Myzus rilius*, did not seem to control it or any other Aphis in this country, nor had any pest like the mussel scale been kept down in Britain by such means. Year after year we had the same insect pests and their parasites in varying numbers; moreover, the parasites did not appear in such numbers as to do any good, until the pests had finished their work and damaged the crops.

F. A. LOWE said that the whole subject of the value of para-

sites as a control of pests required a more extended scientific investigation than had hitherto been accorded to it. Where artificial methods could be effectively employed, nothing was safer, but in situations where the pest had entrenched itself beyond the reach of insecticides or cultural methods, as for instance the Gipsy moth in the forests and woodlands of Massachusetts and the New England states, or where for other reasons artificial methods could not be employed, then the natural enemies must be brought into play as a check. The point was that artificial methods were certain in their action, and could be used quickly again and again, until satisfaction was obtained, whilst with parasites it was necessary to wait until their season came round, and it usually took time to bring about a check.

W. HOEY stated that he spoke, not as an entomologist, but as an administrator interested in Indian agriculture. Sugar cane was widely grown in India, and was planted on the best soil and manured. It was liable to attack by pests. In one province there was an immense tract of land of rich, moist soil, all over which were to be found stone sugar mills, many of them inscribed with dates showing that hundreds of years ago they must have been in use. Now these were idle, and the whole of this tract was overrun with a wild growth of Kāns, a robust, cane-like, reedy-looking plant, with roots extending to great depth. This had been described by some as *Sacharum spontaneum*. Anyway, it bore a resemblance to sugar cane, though but of comparatively thin stalk, and it had been supposed that it was originally sugar cane, and had degenerated to a wild state. This might have happened when in some remote time the devastation of war or pestilence had depopulated the region. Nothing could eradicate this weedy growth, and a pest which would destroy it would be a public benefactor. If this were a form of sugar cane, how did it flourish as a wild growth, unattacked, as far as had been observed, by pests? Was it possible that the high cultivation to which sugar cane was subjected as a crop rendered it liable to the attacks of pests? Did sugar cane, allowed to grow in less carefully selected or unprotected surroundings, prove immune to similar pests? Inquiries on such lines as these might lead to fruitful results.

R. NEWSTEAD made some further remarks, touching on the

effect of birds, especially titmice (*Paridæ*), in keeping in check certain coccid pests in Britain.

Sir D. MORRIS, replying to a question, stated that sulphur had been used in the W. Indies against attacks of *Eriophyes gossypii*, but that its use had been discontinued, as the cost of the sulphur was greater than that of the labour required to collect the infected leaves of the cotton plants. In closing the discussion, he referred to the work previously done in the W. Indies by Mr. MAXWELL LEFROY, and to that now being done by Mr. BALLOU and other entomologists.

P. SPEISER read a paper on behalf of J. DEWITZ entitled :

DIE PHYSIOLOGIE IN DER SCHÄDLINGSFORSCHUNG.

The author dealt with the disproportion in the sexes of the specimens of Lepidoptera attracted by light, the influence of external and internal factors on the bionomics of insects, and the physiological effect of insecticides (cf. Vol. II., p. 234).

V. I. KELLOGG expressed his appreciation of the paper, but no further discussion took place.

R. STEWART MACDOUGALL's paper on "*Heteroptera* and *Thripidæ* as apple enemies" was withdrawn, and the meeting then rose.

MONDAY, AUGUST 5TH, 2 P.M.

SECTION II.—SYSTEMATICS AND DISTRIBUTION.

President: CH. OBERTHÜR.

Vice-President: D. SHARP.

Secretary: G. ARROW.

In the absence of the President and Vice-President, the Hon. N. C. ROTHSCHILD kindly undertook to act as President, and called on Prof. H. J. KOLBE to give his paper entitled:

DIE DIFFERENZIERUNG DER ZOOGEOGRAPHISCHEN ELEMENTE DER KONTINENTE.

Many genera are common to America and Europe, and many species identical. As we go more northwards, the identity of genera and species increases. Fossils are no guides, as they are too few in numbers. Genera exist in America and Eurasia which may be regarded as relics. *Asida*, e.g., occurs in Mexico, Texas, California, etc., and again in Southern Europe northward as far as the Rhinegau. Glaphyrinæ are found in North Africa, Southern Europe eastward to China, and also in California. Such genera have formerly occurred farther north.

Melolontha and *Cetonia* only occur in Europe and Central Asia; no representatives are known from America. Such genera have probably immigrated from the south, and have consequently not been able to reach America.

Certain groups, now distributed over the European-Asiatic region, have had their origin in Central Asia.

Northern districts possessed a rich flora in Tertiary times (known from fossil remains), including forms now only found much farther south, so that they were undoubtedly formerly inhabited

by a rich fauna. There is no reason to doubt that the insect fauna was also abundant.

This fauna has been forced southwards by the advancing ice, and this accounts for the relationship of the two territories.

Some Coleoptera of Tertiary times in Europe resemble those at present existing in America. Seven or eight fossil species of *Calosoma* are known in Europe, where at present only five species exist. America has more than twenty, some of which resemble fossil European ones.

Archaic genera are much more numerous in North America than in Europe. North America has been mostly continental since Tertiary times; Europe was formerly a group of islands. The fauna of the former consists of archaic types (relics), a large percentage of immigrants from the circumpolar continent, and finally immigrants from the south. The European fauna is composed of immigrants from the north and from Africa and Asia.

The Antarctic continent has a fossil flora bearing relationship to South America. There is also an affinity between Chile, Patagonia, Australia, and Madagascar. Many genera have extended from North to South America, and from North Asia to Australia (cf. **Vol. II.**, p. 433).

Discussion.

P. SPEISER.—Die Ausführungen des Herrn Vortragenden werden durch unsere Erfahrungen an den Dipteren unterstützt. Alte Formen, wie z. B. solche, die schon im Bernstein stark vertreten sind, finden sich in Mittel-Amerika und West-Afrika (*Toxorhina*). Wo Gemeinsamkeit zwischen Nord-Amerika und Nord-Europa fehlt, wird es sich um phylogenetisch junge Formen handeln. Einiges zu dieser Frage aus dem Gebiete der Blutsauger soll mein auf Freitag angesetzter Vortrag bringen.

N. BANKS said that in one family of Neuroptera, the *Panorpidæ*, it was the Eastern United States that was related to Europe, while with the *Raphididæ* it was the Californian region that was so related. With the Myrmeleonid genus *Palpares*, the Mediterranean region, all Africa, and India made one region; with the Ascalaphid genus *Ascalaphus*, the Mediterranean region, Central Asia, and Japan made one zoological region. Therefore

he considered that the distribution of each family, as far as concerned recent forms, would show different regions according to the family.

A. PORTER was to have read a paper entitled :

A CATALOGUE AND BIBLIOGRAPHY OF CHILIAN COCCIDÆ,

but being absent, W. HORN was called upon to give his paper entitled :

DIE FORTSCHRITTE DES NEUEN COLEOPTERORUM CATALOGUS
VON JUNK-SCHENKLING.

W. HORN recalled the famous *Catalogus Coleopterorum* of GEMMINGER and HAROLD (1868-76), which comprises about 77,000 species, but which now long since is out of date. There was great difficulty not only in finding enough specialists for working up the different groups of beetles, but also in finding an editor for the great new Catalogue.

Some idea of the work involved might be obtained by the number of one single family of Coleoptera, the Curculionidæ, 75,000 species of which had already been described. Now the Catalogue was going rapidly ahead ; all groups of beetles were in charge of specialists ; the first part was issued in 1910. A brief comparison was given of the numbers of species of the old GEMMINGER and HAROLD'S Catalogue and the new one : it proved that generally the numbers had increased in the proportion of 1:3. Special attention was drawn to the great expense of editing the work, as there was no chance at all of obtaining official help : an appeal was therefore made to all entomologists, and all entomological and zoological institutions, etc., to do their best in the interest of the Catalogue. The entomologists of the U.S.A. were especially asked for assistance, since the Catalogue was very important from a practical point of view, as it included the literature on economic entomology (cf. Vol. II., p. 192).

Finally, W. HORN mentioned the *Lepidopterorum Catalogus* of JUNK-WAGNER, which had been quite lately undertaken. The difficulty was not so much in the number of the species as in the want of specialists who were willing to assist. He appealed to English lepidopterists for their co-operation.

Discussion.

A. SEITZ gibt zu erwägen, ob nicht durch eine Herabsetzung des Preises eine Zunahme der Abonnenten des Katalogs zu reichen wäre.

Hon. W. ROTHSCHILD.—Some confusion existed amongst English entomologists as to the Catalogue being a rival of that of the British Museum. This was not the case, but it supplemented the latter, and moreover contained no descriptions and brought in extra synonymic and bibliographical material.

Replying to questions, W. HORN stated that the difficulty in regard to the *Lepidopterorum Catalogus* was not caused by the relatively great expense of the separate numbers of the catalogue, but by the fact that for many of the groups it was difficult to find competent authors.

The meeting then rose.

TUESDAY, AUGUST 6TH, 10 A.M.

GENERAL MEETING.

President : A. LAMEERE.

Vice-President : J. VAN BEMMELEN.

Secretary : H. ELTRINGHAM.

The President asked the Secretary to make certain communications to the meeting.

The Secretary announced that :

(1) Messrs. WHEELER and BETHUNE-BAKER's paper would be given in that room in the afternoon at 2 o'clock.

(2) Mr. NEAVE's paper would be given that night in Room A at 8.30 instead of on Thursday morning.

(3) He had received a private letter from the General Secretary, Dr. MALCOLM BURR, stating that owing to the continued illness of Mrs. BURR, he would be unable to be present during the whole Congress, but that he hoped to attend for a short time on Thursday.

(4) Dr. GORDON HEWITT, representative of the Government Department of Agriculture of Canada, would arrive that day.

(5) Sir NEWTON MOORE, representing the Government of Western Australia, would arrive on Wednesday.

(6) Dr. H. DZIEDZICKI had telegraphed from Warsaw regretting his inability to be present and conveying his best wishes to the Congress.

(7) Dr. JOHANN SCHNABL had sent a similar telegram.

(8) A telegram had been received from the Entomological Society of Belgium, wishing the Congress every success.

On the motion of the President a vote of sympathy with Dr. BURR was unanimously carried, and Mr. ELTRINGHAM was requested to convey the same to him by letter.

The President in introducing Prof. COMSTOCK said :

Je propose en exemples aux Entomologistes du Continent nos collègues américains qui ont en nombre considérable traversé l'Atlantique pour assister à ce Congrès. Je rappelle les titres que M. le Professeur COMSTOCK s'est acquis à la reconnaissance des naturalistes par ses savants travaux, et je fais notamment allusion à ses recherches décisives, en collaboration avec M. NEEDHAM, sur la nervation des ailes des insectes.

J. H. COMSTOCK then read a paper entitled :

THE SILK OF SPIDERS AND ITS USES.

Silk production, he said, had reached its highest development in spiders, in which seven different types of silk glands were to be found. The original use of the silk was doubtless for the protection of the eggs. The different kinds of silk described. The method by which the spider swathes its prey in silk. The "drag line," composed of a few strands of silk. The elastic threads forming the foundation of the viscid spiral. The threads of the egg sac. The swathing film of the *Theridiidæ*. The stretching of the supporting threads, and their subsequent relaxation, causing the viscid coating to separate into drops. The flat ribbon-like hackled bands of the *Cribellatæ*, consisting of two or four longitudinal bands, the "warp," and a viscid sheet-like portion, the "woof." Structure of the hackled bands in various families. The complicated hackled band of *Filistata hibernalis* (cf. Vol. II., p. 1).

Le Président, en remerciant M. le Professeur COMSTOCK de sa communication si intéressante, exprime le vœu que son travail puisse engager les jeunes entomologistes à s'attacher à l'étude, si négligée aujourd'hui, des Araignées.

The meeting then rose.

TUESDAY, AUGUST 5TH, 11 A.M.

SECTION—EVOLUTION, BIONOMICS, AND MIMICRY.

President : Y. SJÖSTEDT.

Vice-President : H. SKINNER.

Secretary : L. DONCASTER.

The President called on E. B. POULTON to give his paper entitled :

MR. C. A. WIGGINS'S AND DR. G. H. CARPENTER'S RESEARCHES
IN MIMICRY IN THE FOREST BUTTERFLIES OF UGANDA.

(No manuscript received for the *Transactions*, but the following abstract sent in by Prof. POULTON gives all the main points.—EDITORS.)

Prof. POULTON exhibited a long series of the commonest species of *Planema*, together with their Nymphaline, Acræine, and Papilionine mimics, collected by Mr. C. A. WIGGINS, D.P.M.O. of the Uganda Protectorate, in forest-patches in the neighbourhood of Entebbe. The exhibited series formed the continuation of that shown at Brussels¹ and published in the *Report of the First International Entomological Congress* (pp. 483–508). The later captures, on the whole, strongly supported the conclusions that had been drawn from the earlier. Together with the great collection from Entebbe, Prof. POULTON exhibited Dr. G. D. H. CARPENTER's fine series of the same mimetic groups, so far as they were represented in Damba Island and Bugalla, one of the Sesse Islands,—both in the N.W. of the Victoria Nyanza. Dr. CARPENTER's groups formed a most interesting contrast with those collected by Mr. WIGGINS. On both islands the *Planema* models were relatively rare, and the Nymphaline mimics of the genus *Pseudacræa* unusually abundant—a relationship reversed

¹ On Dr. C. A. Wiggins' *Researches on Mimicry in the Forest Butterflies of Uganda* (1909).

on the mainland in the neighbourhood of Entebbe. Corresponding with the relative scarcity of the models, the island *Pseudacræas* are more variable and more connected by transitional forms than on the mainland. The islands were in fact ideal spots on which to test Dr. KARL JORDAN's conclusion that *Pseudacræa hobleyi*, *terra*, and *obscura*, were the polymorphic forms of a single species.¹ Dr. CARPENTER's numerous transitional forms certainly afforded strong support to Dr. JORDAN's inference, but the speaker hoped for still more convincing and indeed incontrovertible evidence. For many weeks Dr. CARPENTER had been vainly trying to obtain ova from female *Pseudacræas* in Bugalla Island, but at length, on June 16th last, he observed an egg laid by a female *obscura* with distinct traces of the pattern of *hobleyi*. The parent escaped, but the egg hatched and the caterpillar flourished, and Dr. CARPENTER had written :

"There is just time for the egg, larva and pupa to develop before the Congress at Oxford is over, so that should the offspring be *terra* or *hobleyi* I will let you know. As of course there will be no time to *write*, I will cable, just the one word, either *hobleyi* or *terra*. If it is *obscura* I won't cable, but will, of course, write. I feel that it will be such a splendid opportunity for making this result known, when you will be showing the *Pseudacræas* with especial intent to prove their conspecificity by the intermediate forms."

The cable had not yet arrived, but the speaker hoped that the result might yet be announced to the Congress at a future meeting.² Although he had not been able as yet to publish this result, Prof. POULTON felt sure that members of the Congress would appreciate the splendid work done by these two naturalists in Uganda, and the fact that each of them had thrown so much light on the results achieved by the other.

¹ "The Systematics of some Lepidoptera which resemble each other, and their bearing on general questions of Evolution," by Dr. KARL JORDAN, *J. Congr. Int. Ent., Brux.*, 1910, pp. 385-404.

² The cable with the word "*terra*" reached Prof. POULTON in the Isle of Wight, on August 19th, 1912, nine days after the end of the Congress. The discovery was published in *Nature* for September 12th, 1912, p. 36, and on November 6th the specimen itself was exhibited, together with other *Pseudacræas* bred on Bugalla by Dr. CARPENTER, at a meeting of the Entomological Society of London (*Proceedings*, 1912, pp. cxiv-cxviii.).

Discussion.

H. SKINNER called attention to the fact that E. B. POULTON had created an interest in the subject of mimicry in America. His address several years ago in Baltimore, which had been published in the *Annals of the Entomological Society of America*, was a valuable contribution to the subject. Through his efforts American entomologists had taken up the problems, and it was very likely that valuable observations would come from America that might help to solve some of the laws of Nature in this relation. The S. American butterfly fauna was a most promising one, and should be carefully examined in conjunction with those of Africa and other countries.

F. WICHGRAF, in support of the facts brought before them by Prof. POULTON, remarked that the female form of *misippus* in S. Africa mimicking *D. dorippus* showed that the model which was no longer to be found in S. Africa had formerly existed there.

R. C. L. PERKINS read a paper entitled :

THE COLOUR GROUPS OF HAWAIIAN WASPS.

(No manuscript received.—EDITORS.)

Discussion.

The Hon. W. ROTHSCHILD remarked that the extermination or disappearance of the natural enemies, birds and lizards, was not entirely due to man, but the natural exhaustion of the protoplasm was the cause of our now seeing only the evolutionary result in these wasps, and no longer the cause, or indirect cause.

Rev. F. D. MORICE said that practically all the European wasps belonged to one of Dr. PERKINS's groups, the black striped with yellow. Crossing the Mediterranean we immediately came to other types of colour, e.g. unicolorous yellow, mostly in the great sandy deserts, deep black with black wings, the typically Synagrid pattern of orange-based black abdomen, etc. He expressed his personal conviction that some of these phenomena were certainly due to "adjustment to surroundings" (cryptic) and others to "Müllerian association."

E. B. POULTON said that they must all have been greatly interested in hearing Dr. PERKINS's paper on a subject he had

studied so thoroughly and had done so much to illuminate. It was most fortunate that before this remote and isolated fauna had been greatly injured by the interference of man, Dr. PERKINS had made its study and investigation the chief object of his life. As regards the interpretation of the colour groups of the Hawaiian wasps, he felt that if a naturalist with Dr. PERKINS'S insight and experience could suggest nothing but Müllerian mimicry as the motive cause, it was extremely improbable that the effects were due to any other undetected force or set of forces on that limited area. Therefore, however dissatisfied Dr. PERKINS might be with the only cause that was not beset with innumerable difficulties, for his part he firmly believed that the colour groups had been produced by Müllerian mimicry.

The Rev. K. ST. A. ROGERS then read a paper entitled :
MIMICRY IN THE TWO SEXES OF THE E. AFRICAN LYCÆNID
ALÆNA PICATA E. M. SHARPE.

The butterflies *Alæna picata* and *A. rollei* are really the female and male of the same species, and mimic a *Neptis* and an *Acræa* respectively. Description of habits (cf. Vol. II., p. 220).

Discussion.

H. SKINNER called attention to the fact that in the S.W. part of the United States butterflies flew in the rain, but in the eastern part of the country they disappeared as if by magic when the sun was obscured.

G. B. LONGSTAFF asked whether the butterfly settled with head downwards or upwards. He agreed that the flight of a *Neptis* was so characteristic that the most general resemblance might deceive its enemies. He emphasised the importance of the number of hours of daylight in which butterflies were not on the move, but possibly their enemies were.

The meeting then rose.

TUESDAY, AUGUST 5TH, 2 P.M.

SECTION I.—NOMENCLATURE.

President: E. B. POULTON.

Vice-President: K. KERTÉSZ.

Secretary: K. JORDAN.

The President, on opening the meeting, said that nomenclature was a subject on which many entomologists felt strongly. Opinions differed frequently very widely, and the Congress was a good opportunity for discussing points of disagreement. He had every hope that the discussion would be most fruitful.

The first paper before the meeting was a Resolution read on behalf of the Entomological Society of London by Mr. G. T. BETHUNE-BAKER (cf. Vol. II., p. 93).

The speaker pointed out the difficulties which had arisen through the impossible names suggested by KEARFOTT, and the ridiculous and unseemly names proposed by KIRKALDY, and gave numerous arguments in support of the resolution. As to the International Committee, he suggested that the International Committee be composed of two or three members of each of the National Committees, elected either by the Committees or directly by the electing Societies.

As the second paper announced for this meeting had a close bearing on the foregoing Resolution, the President asked the Rev. G. WHEELER to read his paper before the meeting entered upon a discussion of the Resolution.

Rev. G. WHEELER:

SUGGESTIONS FOR SECURING SIMPLIFICATION AND PERMANENCY
IN NOMENCLATURE.

Impossibility of applying the rule of strict priority illustrated by SCHRANK'S choice of *V. antiopa* as type of genus *Papilio*. Priority as a general principle should be upheld in contradistinc-

tion to "priority at any price." Desirability of uninomial nomenclature. The same name should never be used for two species of different genera. Strong objection to "nonsense" names. Absurdity of changing w into v and k into c in latinising names. Incorrect orthography should not be perpetuated. The question of figures without descriptions, and descriptions without figures, should be specially considered in each case. Value of the Entomological Committee as a court of appeal for the registration of names. Reference to absurd names recently proposed for *Hemiptera*. Plea for the recognition of varietal and aberrational names, as of great use to biologists and students of variation. Desirability of the same varietal name for parallel variations of different species (cf. **Vol. II.**, p. 97).

Discussion.

The discussion was opened by the Secretary, who said that it was necessary for him to inform the meeting of the steps which had been taken since the First Entomological Congress in the matter of forming an International Committee on Entomological Nomenclature. The Congress at Brussels commissioned the Executive Committee to nominate (not elect) a number of entomologists as members of a committee on Entomological Nomenclature, and to bring these names before the Second Congress. The Executive Committee had taken action accordingly, and this Congress would be asked at the proper time to elect or reject the names suggested by the Executive Committee.

The Executive Committee was of opinion that the scope of the work of the Committee on Nomenclature should be defined at this Congress. In defining this scope of work, they should bear in mind the results of the working of the various committees on Zoological Nomenclature which had been in existence for some considerable time. Rules had been made, and opinions been rendered, and to-day they observed among zoologists a widespread revolt in nomenclatorial matters. Consensus of opinion among working entomologists being the chief aim, the Executive Committee opined that the main work of the Entomological Committee on Nomenclature should consist in collecting the opinions of the specialists in the various branches of Entomology

on every specific point of nomenclature, considering the opinions thus collected, laying a report before the Entomological Congress, and then bringing the matter before the International Commission on Zoological Nomenclature for final consideration.

The Resolution of the Entomological Society of London was then put.

Hon. W. ROTHSCHILD said that it would not be legal to adopt the Resolution in face of the action of the First Congress, which had charged the Executive Committee with the nomination of a Committee on Nomenclature.

Rev. G. WHEELER rejoined that to take out the words referring to the appointment of the National Committees was to destroy the suggestion altogether, viz. that the national committees should appoint the central one, not the central committee the national ones.

L. O. HOWARD objected that the Resolution was not in proper form. It was a resolution of the Entomological Society of London. The meeting might endorse its general provisions, but the resolution must be brought before the Congress in a definite form by the Executive Committee. Dr. HOWARD moved "that the matter be referred to the Executive Committee, to formulate a resolution applicable to the Congress, to be reported at the General Meeting for the consideration of the present Congress."

L. DONCASTER said that in the absence of the appointed representative of Cambridge University to the Congress, he had been asked to convey to the Congress the general support of Cambridge entomologists for the principle of the Resolution submitted by the Entomological Society of London.

A. SEITZ schlägt vor, dass das Komitee auch seinerseits gewisse Garantien gibt, dass die eingereichten Vorschläge und Anfragen innerhalb einer gewissen Zeit erledigt werden. Solche Garantien würden geeignet sein, den Widerstand gegen den sehr annehmbaren Vorschlag der Entomological Society zu brechen.

H. SKINNER had much pleasure in seconding L. O. HOWARD's amendment.

G. A. K. MARSHALL asked whether the Executive Committee had not already considered the Resolution of the Entomological

Society of London, and whether it would not be possible for Dr. JORDAN to bring forward a definite proposal on behalf of the Committee in order to save time.

G. T. BETHUNE-BAKER said that the proposal of the Entomological Society of London did not conflict with the Zoological Commission on Nomenclature, as it did not propose to make laws, but only to lay its views before the Commission and to assist it in every way possible.

K. JORDAN, in replying to G. WHEELER and others, said that the creation of national committees was not feasible if there was no central body which took the organisation of these Committees in hand; but that this was merely a difference in procedure. The Executive Committee would lay a report on the matter before the General Meeting if Dr. HOWARD's amendment should be adopted.

The amendment was then read by the Secretary in English, German, and French, and carried unanimously.

The meeting then rose.

The following letter was handed to the Secretary after the meeting:

MERTON HALL, THETFORD.

(After June 21st, 1912.)

DEAR DR. SHIPLEY,

The Vice-Chancellor informs me that you are appointed a Delegate from the University to the coming Entomological Congress at Oxford. I was sorry to be obliged to decline a similar mission, but am consoled by the belief that we may count upon you to support any sound proposition. The questions connected with Zoological Nomenclature especially demand attention, and I am anxious to enlist your support for such measures as may tend to secure precision and finality and to prevent the system of classical nomenclature from falling into disrepute.

You may possibly have seen the paper by E. MEYRICK "On some impossible Specific Names in Micro-Lepidoptera" (*Entomologists' Monthly Magazine*, vol. xlviii.), which I enclose, together with some comments of my own upon it in the same publication, which I find are in accordance with the views ex-

pressed and published by the Secretary of the London Entomological Society. I am also able to enclose a "first proof" of a resolution adopted by that Society for presentation to the International Congress, and I sincerely hope that you may see your way to support it. The main point I would urge is the necessity for some clear definition of what is or is not a *valid* name, and what corrections are to be permitted. It seems to me that the principle of priority in nomenclature is all-important—for what is the temporary convenience of a few generations of zoologists in using habitually accepted names, as compared with the value of precision and finality in the enduring life of scientific study? It is impossible to eliminate all meaningless names as invalid; too many nonsense names have been given in the past, and have been fully accepted. Such a practice, however undesirable, will assuredly be repeated from time to time, but the line of recognition should surely be drawn short of mere alphabetical variations of names which mean nothing. Such a system is equivalent to, or even inferior to, the use of numerals. Such names cannot be remembered, and must lead to constant confusion in literary references. The term "nomenclature" cannot rightly be applied to them, and the authority of the Congress should be bespoken to outrule them absolutely as *invalid*, and to recommend this course to the next International Congress on Zoology through the International Zoological Commission.

Another very objectionable set of names (in this case generic) has been perpetrated by the late G. W. KIRKALDY—"Ochisme," "Marichisme," "Dolichisme," etc., *ad nauseam*. I enclose a memorandum of the sample (*Entomologist*, 37, 1904). These names are merely mongrel creations of names with an English meaning, not classically formed, and surely invalid from their inception. If by any rule such are to be admitted, we may expect "Buttapatta," "Kowcatcheria," "Celavasanderia," "Mafoia," etc., etc. They are infinitely worse than mere nonsense names, which, as I have said, cannot now be dealt with in the same summary manner to which in my opinion these lay themselves open.

It has been suggested that such series of absurd variation have been invented for the special purpose of putting the advo-

cates of priority in a ridiculous position. Their only effect seems to me to be to put in a ridiculous position those extremists, of whom there are many in America and elsewhere, who hold that no first name can be altered or rejected, however wrongly it may have been formed or spelt.

In the *Merton Rules* (Longmans, 1896), of which I also enclose a copy, Rule 29 provides a remedy. These *Rules* have been very widely and more generally accepted year by year since their publication—I have not yet met with any case with which they do not deal in a satisfactory manner when rightly understood and interpreted.

The principle they guard is the principle of priority not only in nomenclature, but in all scientific work and revision—*i.e.* any author's work must be accepted, to the exclusion of subsequent alterations, until proved to be incorrect.

Forgive me for thus putting the case before you. I wish that I could myself have undertaken the duty of attending the Congress. Please endeavour to enlist the sympathies of your colleagues from the University, and of as many others as possible, to defend Zoological and especially Entomological Nomenclature from the fate with which it is threatened of being drowned in a butt of ridicule. Pray make any use you please of this letter, for the furtherance if possible of the argument it contains—

And believe me,

Yours sincerely,

WALSINGHAM.

The President then called on M. CHARLES OBERTHÜR, who proceeded to defend with great eloquence his thesis :

PAS DE BONNE FIGURE À L'APPUI D'UNE DESCRIPTION, PAS DE
NOM VALABLE.

(No manuscript received, but the following abstract has been compiled from notes handed to the Secretary by M. CHARLES OBERTHÜR.—EDITORS.)

Nous faisons l'inventaire des espèces qui peuplent aujourd'hui le globe. Il paraît utile de faire connaître d'une façon cer-

taine aux générations futures les espèces que nous connaissons encore aujourd'hui. Chaque espèce ou variété doit avoir un nom qui la désigne à l'exclusion des autres espèces ou variétés. Mais la nomenclature est très confuse ; il est temps d'arrêter le dommage et de chercher à améliorer pour l'avenir la situation présente. Il est très difficile de trouver le nom d'une espèce et de savoir si elle est déjà connue ou non. Que faut-il pour que la connaissance d'une espèce soit assurée ? Il est nécessaire que la description soit accompagnée d'une figure ; l'une et l'autre se complètent réciproquement. La description sans figure est généralement inintelligible. La figure seule laisse quelquefois ignorer des particularités sur lesquelles il convient d'appeler l'attention. Pour la figure, la photographie donne fidélité, rapidité, économie. Il y a deux situations ; celle qui résulte du passé et celle qui interviendra dans l'avenir. Faisons l'avenir meilleur que le passé. Il me semble que nous devons tous nous trouver d'accord sur le principe suivant : La publication de chaque espèce ou variété supposée nouvelle doit être faite de façon qu'aucun doute ne reste désormais dans les esprits au sujet de la manière d'être de l'espèce, variété, ou race à laquelle un nom nouveau est attribué. Je signale un mal. Je demande qu'on étudie, d'ici au prochain Congrès, le moyen de remédier au passé. Pour cette fois, je demande que le vote du dernier Congrès soit fortifié par l'addition de la photographie à la description, faute d'une figure coloriée bien exécutée, ce qui est cependant le meilleur.

As Mr. L. B. PROUT, who was prevented from attending the Congress, had sent in a paper on the same subject, the President called on the Rev. K. ST. A. ROGERS to read the paper for Mr. PROUT :

Abstract : Illustrations may be an assistance, though they are not necessarily indispensable. Numerous cases where specific differences are more easily recognisable by small differences of structure than by wing pattern. Over-emphasis on illustration would tend to retard progress in study of structure. Many instances given where good description is of more value than figures, also instances where even good figures are of little value, owing to incomplete description. In the case of local races, etc.,

it would be absurd to require a figure to illustrate some feature of differentiation which would quite easily be recorded in words. Summary and conclusion (cf. **Vol. II.**, p. 166).

Discussion.

Considerable interest was taken in the question brought forward by M. CHARLES OBERTHÜR.

ALFRED SICH said that in his opinion a description was of far greater value than even an excellent figure. If we had the figures of two closely allied species before us, we might be unable to discover the very slight points of difference, which a few lines of description would be sufficient to point out. Even if the proposition were brought forward as a law, how could we compel the observance of such a law?

WALTER ROTHSCHILD would have been willing to support a motion for the desirability of each description being accompanied by a coloured picture, a photograph, or a drawing of the essential differences, but must oppose the proposition that the validity of a name be made dependent on the description being accompanied by a figure. It would certainly lead to a deterioration in the accuracy of the descriptions, and breed great mischief.

ED. EVERTS.—In the Coleoptera it was often quite impossible to give sufficiently accurate figures supplementing the descriptions. A large proportion of the small Staphylinidæ, for instance, could only be recognised from good descriptions; figures of *Homalota* and *Stenus*, e.g., were quite valueless. In the case of Lepidoptera, the pattern appeared as a kind of tapestry, and could often easily be copied in colour. We should therefore demand (1) a *good* description, and (2) figures where possible and necessary.

G. B. LONGSTAFF stated that M. OBERTHÜR's proposal was as charming as the language in which he advocated it, but that he had often found it impossible, even in the case of the larger Lepidoptera, to distinguish good specimens of allied species in the cabinet without the aid of descriptions.

E. M. DADD.—Figures were a great help in the identification of butterflies and the larger moths, but, unless considerably enlarged and very carefully drawn, were absolutely useless in

working out small and closely allied species, such as *Tephroclystia* (= *Eupithecia*), *Microlepidoptera*, etc. It had been suggested that photography would be a good medium, but he defied anybody to name nearly allied species of *Tephroclystia* from the best photographs. Even good coloured figures would be useless, unless accompanied by a detailed description. In the case of small species, only considerably enlarged and carefully executed drawings would be of any assistance, and their cost would be prohibitive to any one not possessed of considerable means.

H. SCHOUTEDEN se rallie complètement à ce qu'ont dit MM. EVERTS et LONGSTAFF sur l'impossibilité de reconnaître d'après des figures même bonnes des espèces fort voisines. Il cite deux cas où, sans la description, il eût été fort difficile de reconnaître des erreurs du dessin. L'un des cas est celui d'un Hémiptère examiné par lui au British Museum, et dont il a reçu plus tard une figure faite d'après le même exemplaire par un des meilleurs artistes anglais. En vérifiant le dessin il constata l'intercalation d'un segment là où il n'y avait qu'un léger sillon. S'il n'avait pas vu le type il eût certainement cru le dessin exact.

L'autre cas concerne la reproduction photographique, cas d'une aile de *Libellula* dont la photographie était parfaite. Or le cliché qui en fut reçu de l'établissement de photogravure montrait une partie des nervures complètement modifiée : l'ouvrier chargé de préparer ce cliché simili avait par accident détruit une partie de la nervation et—avait cru pouvoir la reconstituer ! Si ce cliché avait été publié—et sans description précise—cette erreur eût sans doute causé bien des confusions.

La description, elle, doit être aussi précise que possible, et c'est surtout à elle qu'il faut pouvoir recourir pour vérifier ses identifications.

E. OLIVIER.—La proposition de notre éminent collègue me semble réaliser l'idéal de l'entomologiste descripteur. Une bonne figure accompagnée d'une bonne description fixe pour toujours la nomenclature et facilitera grandement la reconnaissance des espèces. Mais on est bien obligé de tenir compte du côté financier. Les photographies peuvent certainement être obtenues facilement ; mais si l'usage des dessins entre jamais dans la pratique, les publications et les sociétés scientifiques se

trouvent encombrées de clichés et se verront forcées de restreindre la publication des desseins que leurs seront adressés. Il s'en suive que le but ne sera pas atteint.

G. SEVERIN estime qu'il est dangereux d'émettre le vœu d'obliger tous les auteurs d'ajouter des figures à leurs descriptions sous peine de ne pas être valable. Il vaut mieux rester au vœu du 1^{er} Congrès. Les figures coloriées sont faciles à faire pour les Papillons, mais presque impossible pour les petites formes—petites Diptères, Hymenoptères, Acariens, etc.

Les figures par la photographie sont à rejeter pour la plupart des détails anatomiques et pour des caractères qui se présentent mal comme disposition naturelle. De plus, la photographie est compliquée alors et rendue impossible à tout le monde. Acceptons des figures simples et dures, faites par l'auteur lui-même autant que possible, quand cela est nécessaire.

W. ROTHSCHILD further said that, however careful the author and artist might be, there would still be the colourists to reckon with, who often used Chinese white instead of a permanent white. Although peroxide of hydrogen would restore the white colour temporarily, it would also obliterate water-colours altogether.

J. H. DURRANT briefly mentioned the chemical decomposition already referred to by Mr. ROTHSCHILD, and also called attention to the beautiful figures of CURTIS, specially mentioned by Mr. PROUT. He pointed out that the figure of *Eriocephala calthella* showed a beautiful frenulum, not possessed by any Jugatæ!

M. OBERTHÜR having replied to the various criticisms, the discussion was closed without a vote being taken.

Before the meeting rose, H. SKINNER, on behalf of Dr. CALVERT, presented the following record in regard to the question of priority in nomenclature :

Votes on Strict Priority.

Scandinavian Zoologists for	2,	against	120
German	„	„	11,
American Entomologists	„	95,	„
			191
<hr/>			
	for	108	against 426

TUESDAY, AUGUST 6TH, 2 P.M.

SECTION II.—MORPHOLOGY AND ANATOMY.

President: P. P. CALVERT.

Vice-President: J. C. H. DE MEIJERE.

Secretary: R. S. BAGNALL.

F. A. DIXEY read a paper on :

THE SCENT-PATCHES OF THE PIERINÆ.

The scent apparatus may be in the form of scattered "plume-scales," or may occur as patches of specialised scales. Structure and position of the patches in *Dismorphia*. Structure of the scales in patches of *Dismorphia* (*Acmepteron*) *nemesis*. The fact that the patches are not visible when insect is at rest, and do not contribute to the general pattern, is evidence that the pattern has been evolved under natural selection. When the scales have been removed, the wing still shows a peculiar appearance, due to the scale sockets, which differ from those on remainder of wing. Structure of patches in *Acmepteron virgo*. In *Dismorphia praxinoe*. In *D. fortunata*. In *D. pallidula*. Tracheæ not evident in patches of *Dismorphia*, but present in several other genera, e.g. *Catopsilia*, *Colias*, *Teracolus*, etc. Structure of patch with tracheæ in *Teracolus fausta* and *Catopsilia florella*. Possible function of the air vessels.

The paper was illustrated by lantern slides (cf. **Vol. II.**, p. 336).

Discussion.

G. B. LONGSTAFF said that he had observed scents in different butterflies to differ not only in quality, but in quantity or volume, and in duration. He thought it likely that the anatomical relations might prove to be different in different species.

J. C. H. DE MEIJERE remarked that he did not believe that the air vessels had anything to do with the expulsion of the odour, as the scent scales were connected with gland cells, and in insects in general glandular regions were largely provided with a quantity of tracheæ.

F. A. DIXEY, in reply to the discussion, agreed with Dr. LONG-STAFF that both the volume and duration of the odour differed much from species to species. There was no doubt that the anatomical relations were different in different cases. He had pointed out that the special distribution of tracheæ described by him was only to be found in relation with certain circumscribed scent patches, and not in connection with the generally dispersed scent scales. He fully agreed with Dr. DE MEIJERE that the glandular structures in insects and other Arthropoda had usually a peculiarly rich supply of tracheal branches, but he could not help thinking that there was some more special significance in the distribution to the scent patches. He had elsewhere attempted to connect this with the differences in structure which characterised respectively the two kinds of scent scale.

G. H. CARPENTER then gave his paper entitled :

THE PRESENCE OF MAXILLULÆ IN BEETLE LARVÆ.

Importance of the maxillulæ as corresponding with the first maxillæ of Crustacea. Larva of *Dascillus cervinus* chosen for examination. Maxillulæ found in this larva, and also in that of *Helodes*. In *Phyllopertha* the structure is asymmetrical. Account of a *Helodine* larva found at leaf bases of Bromeliaceous plants in W. Indies. Maxillulæ recorded by MANGAN in larvæ of *Dytiscidæ*. Presence in *Pterostichus* of structures corresponding to the maxillulæ in *Dytiscidæ*.

The paper was illustrated by lantern slides (cf. **Vol. II.**, p. 208).

R. S. BAGNALL said that he had examined the mouth parts (and the maxillulæ) in many species of Symphyla, Isopod Crustacea, Thysanura, and Crustacea, and also the foot of the Thysanura, Collembola, and the larvæ of various beetles, and he considered that the Thysanura foot had affinities on the one side with the Symphyla, and on the other with the larvæ of certain beetles, mentioning certain *Scydmanidæ* and *Dermesters*. He mentioned TOMOSVÁRY'S description of a supposed new type of Thysanuran, *Anisosphærius*, which was later discovered by SILVESTRI, and raised as the type of a new group of Thysanura

in 1904, only to be shown the year following to be the larva of a Scydmanid beetle of the genus *Cephennium*, a larva which he had himself discovered and examined. He said that he thought that the study of the mouth and foot structure in certain beetle larvæ would prove of much interest.

G. HORVÁTH then read a paper entitled :

SUR LA CONSTRUCTION DE L'ÉLYTRE DES CICADIDES.

After referring to the excellent work of COMSTOCK and NEEDHAM on the wings of insects, the author proceeded to give a detailed account of the structure and development of the longitudinal and transverse nervures in the *Cicadidæ* (cf. **Vol. II.**, p. 422).

The President and Prof. COMSTOCK briefly expressed their appreciation of the communication.

The Reverend Padre S. J. LONGINOS NAVÁS read a paper entitled :

ALGUNOS ÓRGANOS DE LAS ALAS DE LOS INSECTOS.

The author described several small structures found on the wings of Neuroptera, and proposed some new genera (cf. **Vol. II.**, p. 178).

Dr. HORVÁTH demande à M. le révérend Père Navás s'il connaît le rôle physiologique de ces organes curieux découverts par lui, et particulièrement de la "bulla."

Le Padre LONGINOS NAVÁS, en répondant au Dr. HORVÁTH, dit que la bulle est convexe à la partie supérieure de l'aile, concave à l'inférieure. Il avoue qu'il ignore le bout physiologique de celui et des autres organes qu'il signale, mais il croit impossible que la bulle soit simplement un organe d'attache des ailes. Chez les genres *Spilosmilus* Kolbe et *Nina* Nav. les ailes postérieures sont toujours libres, les postérieures des *Nina* sont pendantes postérieurement pendant le vol et les bulles des ailes antérieures et postérieures ne se correspondent pas.

P. SPEISER weist darauf hin, dass sich analoge Organe auch

bei andern Insektenordnungen finden. Die "bullæ" kommen als Geschlechtscharaktere, aber in etwas anderer Ausbildung als bei *Spilosmylus* auch unter Tagschmetterlingen vor, z. B. bei *Pararge*. Vor allem sind aber die Unterbrechungen der Queradern eine bei Ichneumoniden und Dipteren viel beobachtete Erscheinung, die darauf hindeutet, dass das Geäder in der phylogenetischen Umbildung begriffen ist.

J. C. H. DE MEIJERE dit qu'il a remarqué chez certains Hyménoptères des petits organes qui lui semblent être identiques à ce qui M. NAVÁS a appelé des pupilles.

Le Padre NAVÁS répondait à M. DE MEIJERE qu'il pourra bien être que la pupille se trouve aussi chez autres ordres d'insectes, outre les Neuroptères. Il lui avait suffi de la signaler chez plusieurs genres de différentes familles.

G. HORVÁTH remarque que la nervure transversale intermédiaire postérieure ne peut être considérée comme une ramification de la nervure cubitale, car celle-ci est aussi dans les moignons élytraux des nymphes toujours tout-à-fait simple sans se ramifier.

The President thanked the authors for their communications.

The meeting then terminated.

In the evening a large number of the members assembled in Room A, to hear Mr. S. A. NEAVE's paper :

TRAVELS OF AN ENTOMOLOGIST IN EASTERN AFRICA.

Mr. NEAVE gave a graphic description of the country through which he had travelled in his capacity as entomologist to the Entomological Research Committee, and gave a most interesting account of the tribes with which he came in contact, mentioning also his experiences in connection with the insects with which he met. The lecture was illustrated by a large number of beautiful lantern slides made from the lecturer's own photographs.

Prof. POULTON remarked on the great interest of Mr. NEAVE's paper as illustrating the actual field of operations whence had come so many entomological discoveries.

No discussion ensued ; a very hearty vote of thanks to the lecturer was unanimously accorded.

WEDNESDAY, AUGUST 7TH, 10 A.M.

GENERAL MEETING.

President : J. H. COMSTOCK.

Vice-President : The Hon. W. ROTHSCHILD.

Secretary : H. ELTRINGHAM.

The Secretary having made certain announcements, the President, in opening the meeting, said that as they had a very long programme for that morning, he would not weary them with extended remarks introducing the speakers, but would merely say that he was sure the members of the Congress were looking forward with much interest to the hearing of the papers ; and that as each of the papers treated of evolution, it seemed very appropriate that they should be presented beneath that roof, where one of the greatest battles in that war of opinions which broke forth on the promulgation of the theory of evolution was fought, and where the honoured President of that Congress was doing so much to extend the bounds of the territory that was won by that conquest.

He had the honour to introduce Prof. VAN BEMMELEN, who would speak on "The Phylogenetic Significance of the Development of the Butterfly Wing."

J. VAN BEMMELEN made reference to a previous paper in which it was shown that there is a pupal wing-pattern independent of, but subsequently absorbed by, the imaginal pattern. Subsequent work in wing-development by other authors. The order in time of the developmental stages of the wings. Observations in the coloration of pupæ at the time of ecdysis. Description of the wing-sheath of *V. urtica*. Comparison of the pupal sheath of *V. urtica* with that of *V. io*. The wing-sheath of *Papilionidæ*. The wing-sheath pattern of *P. machaon* resembles that of *Thais polyxena*. Wing-sheath pattern in *Pieridæ*. Development of the primitive wing-pattern. In *Vanessidæ*. In *Pieridæ* and *Papilionidæ*. Primitive wing patterns exhibited in the

genus *Hestia*. Mimicry possibly to some extent a survival of primitive patterns. Summary of conclusions.

The lecture was illustrated by a fine series of lantern slides (cf. **Vol. II.**, p. 355).

Discussion.

F. A. DIXEY congratulated Prof. VAN BEMMELEN on the beauty and interest of his researches, and remarked that he had thrown a flood of light on the relation shown by the pupal wing, properly so called, and the imaginal wing within the pupa.

T. A. CHAPMAN expressed his admiration of the paper, which touched on subjects in which he was much interested. Time prohibited his more than asking a question as to the development of *Aporia cratægi*, in which the earlier markings of imaginal wings in the pupa corresponded very exactly with the pupal markings, which were very variable and hardly alike in any two specimens, and were therefore quite rarely in correspondence with the true primitive pattern demonstrated by Prof. VAN BEMMELEN to be so usual in certain families of Rhopalocera.

J. VAN BEMMELEN mentioned that he referred to this point in a portion of his paper that time had prevented him reading.

Prof. POULTON, in moving a vote of thanks to Prof. VAN BEMMELEN for his interesting paper, congratulated him on the beauty of his illustrations and also on the admirably clear manner in which he had delivered an address in a foreign language.

J. W. TAYLOR then gave his paper entitled :

GEOGRAPHICAL DISTRIBUTION AND DOMINANCE IN RELATION TO
EVOLUTION AND PHYLOGENY.

The species and groups which have arisen in North Central Europe are the most highly endowed, and better qualified to succeed in the life struggle than those which have originated elsewhere. This leading thought the lecturer substantiated by references to the distribution and qualities of various groups of insects and other animals (cf. **Vol. II.**, p. 271).

Discussion.

G. H. CARPENTER drew attention to the work done in Ireland on the distribution of Britannic insects, which tended to show

the presence of several faunistic groups in our islands. These groups must have had different areas of dispersal. The geographical conditions of the Central European plain during the glacial period rendered it impossible to accept Mr. TAYLOR's contention that that region must be regarded as an universal centre of dispersal for all forms of life.

The next paper was that of L. DONCASTER, entitled :

SEX-LIMITED INHERITANCE IN INSECTS.

A. grossulariata and its form *lacticolor*, and the Dipteron *Drosophila ampelophila* with its white- and red-eyed forms, as examples of sex-limited inheritance. Tables showing the constitution of the gametes in regard to two characters. Importance of determining whether absolute coupling occurs between associated factors, and to what extent the sex is determined in the egg or in the spermatozoon. Desirability of discovering further cases of sex-limited transmission. Probability that some insect which can be bred with rapidity will provide the material required (cf. Vol. II., p. 227).

Discussion.

N. C. ROTHSCHILD asked Mr. DONCASTER two questions :

- (1) If Mr. DONCASTER had read a book called *The Causation of Sex*, and if he agreed with the author's deductions, and
- (2) If an inherited character might not be inherited by a child from its parent irrespective of the sex of that parent.

Mr. DONCASTER replied that he agreed with Dr. RUMLEY DAWSON, in believing that sex was determined in the egg, but that experiment did not support the view that one ovary produced male-determining eggs, and the other female-determining.

As to the second question, it was important to distinguish between the characters which showed sex-limited transmission, and secondary sexual characters, *i.e.* those which appeared in one sex only, though they were apparently transmitted to both.

No further discussion ensued, and the meeting terminated.

WEDNESDAY, AUGUST 7TH, 11.30 A.M.

SECTION I.—ECONOMIC AND PATHOLOGICAL.

President: J. JABLONOWSKI.

Vice-President: R. C. L. PERKINS.

Secretary: J. C. MOULTON.

The President, on opening the meeting, said:

Meine Damen und Herren!

Indem ich die Mitglieder der Sektion freundlichst begrüße und die Sitzung eröffne, bitte ich um Erlaubnis, Sie aufzufordern, einen Augenblick der dankbaren und ehrenden Erinnerung einer englischen Forscherin zu weihen, die auf dem Gebiete der landwirtschaftlichen Entomologie tätig war, und welcher die Wissenschaft sowohl als das praktische Leben zahlreiche und wertvolle Erfolge verdankt. Ich meine die verstorbene Miss ELEANOR ORMEROD, deren Andenken noch heute, fast 10 Jahre nach ihrem Tode, nicht nur die einheimischen, sondern auch die auswärtigen Entomologen, die auf dem Gebiete der landwirtschaftlichen Entomologie arbeiten, hochhalten. Miss ORMEROD war jahrelang im regsten freundschaftlich-wissenschaftlichen Verkehr mit diesen Forschern des Auslandes, und ich glaube, dass es in England kaum eine Insektenschädlingsfrage gibt, über welche die greise Einsiedlerin von St. Albans nicht den lebhaftesten Briefwechsel geführt hat. Und diese erfolgreiche Tätigkeit ist um so mehr zu schätzen und um desto höher anzuschlagen, weil ihre lange Jahre hindurch fortgesetzte Arbeit in vollkommenster Weise selbstlos, altruistisch war. E. ORMEROD scheute keine materiellen Mittel, um andern mit Rat zur Seite zu stehen.

Es ziemt sich also wohl, ihrer bei dieser Gelegenheit zu gedenken, wo eine Sektion des II. Internationalen Entomologen-Kongresses mit einem Thema beschäftigt ist, woran in England sie allein mit Ausdauer und Liebe gearbeitet hat. Ihre zahlreichen Reports, Manuals, etc., nehmen einen ehrenvollen Platz ein

unter den Arbeiten jener Bahnbrecher, welche die Grundlage der neuern landwirtschaftlichen Entomologie gelegt haben. Was Miss E. ORMEROD einst prophetisch in der Wüste verkündigt hat, das hat heute seine eifrigen Anhänger, seine Arbeiter über die ganze Welt. Wir können versichert sein, dass die Erfolge des Zweiges der Entomologie, den unsere Sektion vertritt, ihr die grösste Freude bereitet haben würden. Jedoch die Gesetze der Natur verlangten es, dass, nachdem sie ein ehrwürdiges Alter erreicht hatte, sie vom Leben scheiden musste, ehe die erfreuliche Wendung in der angewandten Entomologie eingetreten war.

Wir wollen ihr Andenken in kollegialer Erinnerung halten.

Laut unserm Programme habe ich die Reihe der Vorträge zu beginnen. Die geehrte Sektion möge mir gestatten, dass ich nach Beendigung des ersten Themas, über die Bekämpfung der marokkanischen Heuschrecke in Ungarn, sofort zum zweiten übergehe, nämlich zur Skizzierung unserer Methode der Bekämpfung der Weinmotten, wie sei eben jetzt in der Praxis in Ungarn eingeführt ist. Ich ersuche meinen geehrten Kollegen, Mr. PERKINS, während der Zeit meiner Vorträge den Vorsitz zu übernehmen.

[As no manuscript has been sent in for publication in the Transactions, the following extensive notes will be welcome to all who are interested in applied Entomology.—EDITORS.]

BEKÄMPFUNG DER HEUSCHRECKEN IN UNGARN.—Zufolge der veränderten hydrologischen und landwirtschaftlichen Verhältnisse Ungarns ist dort seit 1879–80 die ächte Wanderheuschrecke (*Pachytylus migratorius*) nicht nur nicht mehr schädlich, sondern fast vollkommen verschwunden. Da die ungarische Tiefebene immer trockner und der Boden salzhaltiger wird, haust jetzt an Stelle der Wanderheuschrecke der Marokkaner, *Stauronotus* (oder *Doclostaurus*) *maroccanus*, also ein Tier, welches im Küstengebiete des Mittelmeers zu Hause ist.

Dieser Schädling trat zum ersten Mal in den Jahren 1888 bis 1891 auf; zum zweiten Mal 1905–6 und zwar über ein sehr ausgedehntes Gebiet verbreitet (60–70,000 Joch, ein Joch 5,700 qm.). Man bekämpfte den Schädling bei der ersten Invasion mittelst der cyprischen Einfriedigung (appareils cypriotes). Dasselbe Verfahren wurde auch in den Jahren 1905–6 versucht,

aber es zeigte sich bald, dass die riesenhafte Infektion auf diese Weise nicht zu bewältigen sei. Der Vortragende liess infolge kleinerer Versuche im Jahre 1906 fahrbare, 2·5 m. lange Bürsten anfertigen, welche von je zwei Pferden gezogen wurden. In 1907 liess dann der ungarische Staat 275 solcher Apparate machen. Da jeder Apparat von frühmorgens 4 Uhr bis abends 8 Uhr ohne Unterbrechung in Tätigkeit war, konnten mit je einem Apparat 8 Joch gereinigt werden, und da man bis zum geflügelten Stadium 25 Arbeitstage zur Verfügung hatte, wurden 55,000 Joch in dieser Weise behandelt. Der Erfolg war nicht nur ein bedeutender, sondern ein vollkommener. Die Arbeit kostete 270,000 Kronen (einschliesslich der Anfertigungskosten der Maschinen und Reserveteile = 84,000 Kronen ; eine Maschine 300 Kronen). Die Reinigung je eines Joches kam also auf 2·4 bis 2·8 Kronen. Was diese Zahlen bedeuten, kann man nur beurteilen, wenn man sie vergleicht mit dem cyprischen Verfahren, wie es in 1905–6 in Ungarn angewandt wurde. Hätte man obiges Gebiet nach dem cyprischen Verfahren behandelt, so hätte die Arbeit 2½ bis 3 Millionen Kronen, also zehnmal so viel gekostet. Zur Bekämpfung nach dem cyprischen Verfahren hätte man während der 25 Tage je 30,000 Arbeiter nötig gehabt, um die Infektion der 60,000 Joch zu bewältigen, während derselbe Erfolg mit 300 Maschinen, 650 Paar Pferden und 3–400 Arbeitern erreicht wurde. Ausserdem ist man bei dem neuen Verfahren nicht vom Wetter abhängig. Bei der cyprischen Bekämpfungsart kann man nur von früh 8 oder 8.30 bis nachmittags 4 oder 4.30 arbeiten, da in der übrigen Zeit, sowie bei Wind, Regen und Kälte die Heuschrecken nicht zu treiben sind ; ferner muss der Boden eben, ohne hohen Graswuchs und ohne Risse sein, sonst ist alle Arbeit umsonst.

Abgesehen von weitem Vorteilen des neuen Verfahrens will ich nur noch bemerken, dass man in 1909 die fahrbaren Bürsten auch gegen die geflügelten Heuschrecken angewandt hat und zwar bei Nacht, wenn diese Insekten lethargisch sind und nicht fliegen können. Das meint eine Verlängerung der Bekämpfungszeit, und dass man bei genügender Beleuchtung täglich 24 Stunden arbeiten kann. Dies hat die Heuschreckenfrage für Ungarn vollständig gelöst.

Mag aber das Verfahren noch so günstige Erfolge haben,

muss man doch neuen Infektionen vorbeugen. Dieses ist durch das ungarische Landesgesetz vom Jahre 1907, xxxi., vorgesehen, welches die Heuschrecken betrifft und verfügt, dass jedes Gebiet, welches einst inficiert war oder der Infektion ausgesetzt ist (Salterboden, Salzland) nicht bloß unter fortwährender Kontrolle von Seiten der Ortsbehörden steht, sondern von den Beamten (Adjunkt, Assistent oder Hilfsarbeiter) der Königlich Ungarischen Entomologischen Station jahraus jahrein so begangen wird, dass das ganze Heuschreckengebiet innerhalb 3 Jahre durchforscht wird. Auf diese Weise ist man gegen jede Überraschung geschützt und kann beizeiten die nötigen Maassregeln treffen, wenn sich Spuren einer neuen Infektion zeigen sollten.

The lecturer then proceeded immediately with his second paper :

ON THE DESTRUCTION OF COCHYLIS AND EUDEMIS IN THE VINEYARDS.

Der Vortragende weist darauf hin, dass weder mit Giften noch mit den heute gebräuchlichen andern Verfahren den Schädlingen *Eudemis* und *Cochylis* beizukommen sei, weil man durch hygienische Rücksichten und besondere biologische Umstände der Schädlinge gehindert wird. Das Verfahren, welches der Vortragende beschreibt, wurde seit 3 Jahren probeweise nur in kleinem Maasstabe versucht. Da der Erfolg viel versprechend war, wird heuer (1912) ein Versuch in grossem Maasstabe ausgeführt. Die Hauptmomente liegen darin, dass zu der Zeit, wenn der Schädling als Raupe sich im obern Teil des Weinstocks (der Frucht) aufhält, ihm der Weg abwärts zum Winterquartier versperrt und ihm gleichzeitig durch Anbinden der Mottenfalle ein Ort geboten wird, wo die Raupe sich verkriechen und wo man sie nach der Weinlese vernichten kann. Die Arbeit des Zudeckens des Stocks und Anbindens der Fallen muss in Ungarn vom 1. bis 15. August geschehen, aber nicht später. Das Verfahren ist nur bei einr Kultur des Rebstocks wie sie in Ungarn üblich ist anwendbar.

Discussion.

C. WARBURTON said that Prof. JABLONOWSKI's acknowledgment of a debt to English Entomology in the person of

Miss ORMEROD was very gratifying to his English hearers. The response to his invitation to honour the memory of Miss ORMEROD by rising in their seats would have been unanimous had every one understood in time what was desired of him. Any debt in this connection owed by Hungary to England was in a fair way to be paid with interest, and England would certainly have to borrow some of the methods introduced by Prof. JABLO-
NOWSKI against insect pests.

R. C. L. PERKINS also thanked the lecturer for his interesting papers.

A. G. L. ROGERS then gave his paper entitled :

THE NECESSARY INVESTIGATION IN RELATION TO INSECT AND
FUNGUS ENEMIES OF PLANTS, PRELIMINARY TO LEGISLATION.

(No manuscript has been received.—EDITORS.)

Discussion.

C. GORDON HEWITT, in opening the discussion, disagreed with a number of the statements which had been made. Instances were given controverting the assertion that in no case had regulations been responsible for keeping pests out of a country, and that regulations had never been imposed until pests had been introduced. He mentioned examples of English insects, which had proved injurious in N. America. In commenting on the value of lists of injurious species of insects, he pointed out the difficulties introduced through lack of knowledge as to the dangerous possibilities of apparently injurious insects, and the sudden coming into prominence of hitherto uninjurious species. It was not possible, in the present state of our knowledge of the bionomics of native insects, to say whether a species injurious in one country would be injurious or not in another country into which it might be introduced. A thorough knowledge of the bionomics of native and introduced insects was necessary, nor was it always possible to study insects in the mass, especially in the case of introduced species. At present the only safe method was the prohibition of anything but clean imports. The question of the introduction of insect pests could only be dealt with in an

international manner by general discussion and consultation, and such a method of consideration was highly desirable, if only with a view to putting a stop, if possible, to some of the freak legislation in existence.

Mr. A. BACOT said that it was a mistake to consider that *Porthesia chrysorrhæa* was a species which had gradually been exterminated in England. Some twenty years ago, when he was studying the British Liparids, he was unable to obtain living specimens for love or money, yet within two or three years the species had again established itself in its old haunts on the coast of Kent; and it soon spread itself along the shores of the Thames and Medway. After a season or two of extension and plenty on the S.E. coasts of England, the species had died back into its old obscurity, and was absent save possibly in a few favoured spots on the margin of our coasts. At the time when the species was just beginning to wane, he was invited to spend a few days at Ramsgate during late September. He and his friend made a thorough search for the species in the neighbourhood of Ramsgate. On a hedge close to the sea margin at Pegwell Bay, they found the nests of hibernating larvæ in great numbers, yet on the other side of the road, only a few scattered examples could be obtained. He had observed the same restriction over a period of five years at Herne Bay.

He placed a number of nests on Pear in a London garden, and had several colonies of full-grown, healthy larvæ feeding, unsleeved, in the summer of the following year; but although partly formed cocoons were to be found in plenty, in every case the larva had failed to pupate, and the cocoons contained the puparia of a dipterous fly.

There seemed no doubt that this species and *Hypogymna dispar* were prevented from establishing themselves in England by some limiting factor, probably low summer temperature, and in the case of *P. chrysorrhæa* by insect parasites. Broadly speaking, the English environment was such that while little if any danger was incurred from the importation of foreign insects, any English species was a potential danger, if imported into a new continent.

At this point it became evident that the section could not continue through lack of time, and on the motion of Mr. ROWLAND-BROWN the meeting was adjourned until the following day.

At the adjourned meeting on Thursday morning, L. O. HOWARD spoke briefly in commendation of some of the points in Mr. ROGERS's paper, especially that of the importance of studying insect epidemics from every aspect *en masse*. He said that legislation was gradually becoming unified amongst the different countries, and instanced the founding of the English governmental inspection services, and the promised changes about to be made by Belgium and Holland.

R. STEWART MACDOUGALL agreed that it would be of great value if there could be international harmony in regard to organisation and legislation concerning insect pests. He approved of the drawing up by each country of lists of the worst pests in that country, but there were limitations to the value of such lists, inasmuch as the pests of one country were not necessarily severe enemies in another. Legislation, with a view to inspection and the prevention of the entry of injurious forms, would be of great service, but too much might be expected of it. He also agreed with Sir DANIEL MORRIS on the importance of a knowledge of life-history.

W. TEMPLETON spoke as Chairman of the Executive of the county of Lanark. He said that the Government had taken every precaution to inspect cattle, hay, straw, or anything else that might convey diseases to cattle. More might be done in an endeavour to destroy insects which were destructive to fruit, such as wire worms and other enemies of tomatoes and fruits of all descriptions, and he entirely agreed with the proposal that international laws should be passed to prevent any destructive insect finding its way into another country. He also thought that every means should be taken to destroy such noxious insects wherever they might be found.

S. A. FORBES took exception to one of the points especially made by Mr. ROGERS, viz. that no legislative restriction upon trade should be set up because of the possibility of the conveyance of injurious insects and fungi, until it had been experimentally demonstrated that they would be injurious in the country into which they were to be introduced. Their experience in the United States of America had led him to quite the opposite opinion, viz. that they should shift the burden of proof of the innocence of the insect from the country which it threatens to enter to the one which it already inhabits; that they should

insist on an absolutely clean condition of all nursery stock or other plants destined for importation into their respective countries. It was certainly quite impossible for them to determine experimentally the harmlessness of any species for so extensive, variable, and complex a country as the United States.

The discussion on Mr. ROGERS's paper was then closed, and F. V. THEOBALD gave his paper entitled :

APHIDES OF THE CULTIVATED PEAS, AND THE ALLIED
SPECIES OF THE GENUS *MACROSIPHUM*.

Revision of the British species of *Macrosiphum* ; distribution, habits, enemies, and treatment (cf. **Vol. II.**, p. 380).

Discussion.

L. O. HOWARD heartily congratulated Mr. THEOBALD on his important paper. The systematic study, with its result in the way of reducing the number of host plants, was a beautiful example of the value of such study.

In America the pea Aphis was largely controlled by parasites. He expressed surprise at the absence of parasites and interest in the work of birds. Could it be possible, he asked, that the birds had exterminated the parasites in this country ?

GORDON HEWITT thanked Mr. THEOBALD for his important paper, which indicated how dependent was the systematist on the knowledge of the bionomics of an insect. He referred to the occurrence of *Macrosiphum pisi* in Canada, where it was not infrequently controlled by its parasites. He also discussed the methods of control.

W. E. COLLINGE spoke of the value of certain birds which feed on *Macrosiphum pisi*, particularly the Yellow Bunting, Blue Tit, and Whitethroat.

A. T. GILLANDERS said that Mr. THEOBALD's paper clearly showed the value of systematic study to the economic student. The nature of the life-history of the insect under consideration showed that the creature migrated from plant to plant, and the work of the economic student would be of little value if he were not able from systematic study to determine the same or other insects as associated with special food plants.

Sir DANIEL MORRIS proposed that a Committee should be formed, consisting of Dr. HOWARD, Dr. HEWITT, Prof. FORBES, Dr. MACDOUGALL, Mr. WARBURTON, and the President of the Section, to bring forward a resolution on Mr. ROGERS's paper at the next meeting of the Section. Mr. ROWLAND-BROWN requested Sir DANIEL MORRIS to act on the Committee; and Dr. HEWITT having seconded the motion, it was unanimously carried.

S. A. FORBES said that he had received for presentation at the Congress a letter from C. W. MALLY, Cape Province Entomologist of South Africa, which bore directly on the matter under discussion. The essential part of the letter is as follows:

"Insect Pest Regulations are sure to come up for discussion, and I am therefore taking the liberty of sending you a copy of the Agricultural Pest Act for the Union of South Africa, and also the Regulations framed thereunder. The Act, together with the Regulations, really constitutes a consolidation of all the Regulations of the former Colonies—now Provinces—and covers all British South Africa except Rhodesia.

"The outstanding feature of the Act is the limitation of plant introductions to a very small number, and then only by special permit. The object is to enable nurserymen and private parties to get all the new varieties that seem desirable, and at the same time prevent the miscellaneous introduction of common stuff in large quantities. This limitation is really the outcome of the plant-inspection work at Cape Town since 1900, the year I took charge of the work. Up to that time nursery stock was imported in bulk, sometimes as many as 15 to 20,000 trees at a time. In two of these large consignments I found San José Scale, and the whole consignments were therefore destroyed.

"I found it exceedingly difficult to go through such large consignments, and do not feel sure that I have not overlooked some pest or other. The amount of time required was also a very important item, for during the shipping season I could do nothing else, and this coincided with the critical time for the starting of investigation work for the year. It meant that I must do one or the other. With the small lots of trees we can get through them in a reasonable amount of time, and make almost absolutely sure that there is no pest or disease present. When we led the

way in this respect, the other Colonies followed suit, but in course of a few years they eased off on the administration of the Regulations, and again made it possible to get in larger lots of nursery stock, and it is to this fact in large measure that I attribute the presence of San José Scale in South Africa to-day, because the inspectors could not cope with such large consignments time after time, and do the high-grade work necessary to give the desired result. It takes a great deal of character as well as physical endurance to stand up against a big consignment. First of all there comes the inclination to take the work in an easy fashion, because a sense of security soon springs up when tree after tree is apparently clean. It was the dogged determination that it was "the next tree" that saved me from admitting Pernicious (San José) Scale twelve years ago. The greatest danger is that your eyes get tired, and then, though seeing, you do not see.

"The next point I should like to impress is the training and experience of the inspector. If my experience here has shown one thing more clearly than another, it is that the inspector in charge of over-sea plant imports should be the best-trained man money can get. What is the good of an inspector who does not know what he is looking for? We can get plenty of men who know the common species that they see every day, but it takes a properly trained man to see the unexpected or abnormal and grapple with it.

"This brings me to another point in regard to the inspection of plants from over-sea, *i.e.* the exchange of men. Here in South Africa we should have men who know American, European, and Australian insects. At the Eastern American ports there should be men who know European and African insects. At the Western ports there should be men who know Australian, Japanese, and Chinese pests, etc. Australia should have men who know Pacific and South African insects. The Brown Tail Moth was stopped at Cape Town two or three years ago, simply through the fact that Mr. LOUNSBURY's experience in Massachusetts enabled him to recognise the webbed clusters of young larvæ at once, and deal with them accordingly. The same was true in the consignments of Pernicious Scale that I destroyed. It seems to me quite feasible for the different countries to arrange for an exchange of qualified men for this over-sea inspection work."

WEDNESDAY, 11.30 A.M.

SECTION II.—SYSTEMATICS AND DISTRIBUTION.

President: CH. KERREMANS.

Vice-President: S. J. L. NAVÁS.

Secretary: G. T. BETHUNE-BAKER.

The President announced that as time was short, the Section would continue that evening at 9 o'clock, when Dr. JORDAN would give the paper entitled:

ON ARIXENINA BURR, A SUBORDER OF DERMAPTERA.

Also that Dr. JORDAN would immediately afterwards give his paper

ON VIVIPARITY IN POLYCTENIDÆ

instead of on Thursday morning, as announced on the Programme.

He then called on the Rev. J. WATERSTON to read his paper on:

A NEW SCOTTISH PARASITE ON PROCELLARIA.

The paper consisted of a description of the general characters of the new *Mackayia dimorpha* found parasitic on *Puffinus anglorum*. (The paper meanwhile has been published elsewhere.—EDITORS.¹)

At the conclusion the President thanked Mr. WATERSTON for his paper.

Herr DAMPF being unavoidably absent, his paper entitled SYSTEMATIK, GEOGRAPHISCHE VERBREITUNG UND PHYSIOLOGIE DER ARTEN AUS DER HYDRÆCIA NICTITANS GRUPPE was merely announced. (It has subsequently been withdrawn.—EDITORS.)

¹ *The Scottish Naturalist*, p. 251 (1912).

Miss HUIE's paper—

NOTES ON THE VALUE OF ADDING ACETIC ACID TO ALCOHOL
IN THE PRESERVATION OF LARVÆ—

was withdrawn.

The meeting then adjourned.

At 9 o'clock in the evening the section reassembled in Room A, when the President called on KARL JORDAN to give his paper (written conjointly with MALCOLM BURR) on :

ARIXENINA BURR, A SUBORDER OF DERMAPTERA.

A second species of the peculiar genus *Arixenia*, discovered in a cave in Java by Herr JACOBSON, and named by BURR *Arixenia jacobsoni*. Differences between this species and *A. esau* in general proportions, mouth-parts, internal organs. Habits, morphology, and anatomy, particularly organs of reproduction. Viviparity. Illustrated by lantern (cf. **Vol. II.**, p. 398).

K. JORDAN then read a paper on :

VIVIPARITY IN POLYCTENIDÆ.

The family of *Polyctenidæ* is closely allied to the bed-bugs ; the species are only found on bats. Internal anatomy not yet studied, as material is very rare in collections. A specimen in the British Museum contains large embryo bearing combs only on the head, while the mother has combs on head, thorax, and elytra ; less developed embryos observed in other species. Illustrated by lantern (cf. **Vol. II.**, p. 342).

Discussion.

P. SPEISER bemerkt, dass die Auffindung des Embryos mit nur *einem* Dorsalkamm bei einer Art, wo die Nymphe *zwei* und die Imago *drei* Dorsalkämme hat, eine schöne Bestätigung des biogenetischen Grundgesetzes von HÆCKEL bedeutet. Denn die Kämme sind sekundär erworbene Aupassungscharaktere, die ursprünglich gefehlt haben müssen und erst allmählich in reicherer Ausbildung auftraten. Die ontogenetische Entwicklung wiederholt hier die phylogenetische.

Le Président, au nom de l'assemblée, adresse tous ses remerciements à M. le Dr. K. JORDAN pour l'intéressante conférence qui constitue non seulement une étude savante, mais encore un cours complet d'anatomie, de morphologie, et de géographie comparées des *Arixenia*, et une exposition claire et surtout bien exposée de la viviparité des *Polychtenidæ*. On sent, dans ses travaux, la connection profonde du savant, une bonne foi scientifique qui honore celui qui les expose.

The meeting then rose.

Wednesday afternoon was devoted to excursions. So far as atmospheric conditions were concerned, the best that can be said is that in a week of phenomenally wet and cold weather the Wednesday afternoon was perhaps scarcely so bad as most of the other days of the Congress. Indeed, at about 1 o'clock the sun was shining, and it seemed possible that a brief respite from the deplorable conditions of the past three days might be enjoyed.

The numbers of those wishing to take part in the excursions provided proved less than had been anticipated, and it was found necessary to abandon that to Youlbury. For the two remaining trips, however, large and representative parties arrived at the river-landings, and punctually at 2.30 the two steamers left Folly Bridge, one bound for Nuneham, the residence of the Rt. Hon. L. V. HARCOURT, M.P., and the other, under the direction of the late Mr. G. H. GROSVENOR and Commander J. J. WALKER, on a more definitely entomological trip to Bagley Wood.

The Editors are indebted to Mr. H. ROWLAND BROWN and Commander J. J. WALKER respectively for the following accounts:

EXCURSION TO NUNEHAM, WEDNESDAY, AUGUST 7TH.

While a party of the Congress was exploring the entomological treasures of Bagley Wood, and enjoying the hospitality of the President and Fellows of St. John's College, about fifty members availed themselves of the kind invitation of our Colonial Minister, the Rt. Hon. L. VERNON HARCOURT, M.P., to visit Nuneham House. About fifty ladies and gentlemen embarked at Folly Bridge on the launch requisitioned for the purpose, and although the return journey was spoilt by a continuous downpour of rain, it was not until a few minutes after arrival at Nuneham that a heavy shower descended, and kept the Congress within doors. Here every attention was paid them, and they were received by Mr. VERNON HARCOURT, and in the absence of Mrs. VERNON

HARCOURT, by his children, whose French and German was much appreciated by those who were not entirely master of our language. After being shown the various historical paintings and rooms, tea was served in the dining-room, and, this over, the weather having now cleared up, an adjournment was made to the grounds, now in all the full beauty of their summer flowering. Mr. VERNON HARCOURT himself led the party, explaining his methods of gardening to the many who for the first time in their lives found themselves on a typical English country estate. About an hour was thus passed, and then it was time to return to Oxford, the gathering having concluded with a warm speech of welcome and farewell by our host, for whom, as the launch was turned homeward, three hearty cheers were given.

Our Oxford gardens, indeed, appear to have made a special appeal to the minds of the Congress. For example, one of the German delegates, Herr FRITZ N. WICHGRAF, writing in the *Berliner Tageblatt* of August 24th, 1912, says: "We can scarcely have a conception of these gardens, or rather parks, of the Colleges. Each might be a corner of 'Sans Souci,' but with ancient trees of every species in an extraordinary state of healthy vitality, and a luxuriance of vegetation which seemed almost tropical. The box becomes a veritable tree, whilst an infinite variety of conifers, notably cedars and araucarias, flourish in profuse perfection. This is accounted for by the richness of the soil and the damp warmth of the climate, for we had heavy showers every day." (Translated in "As Others See Us," *Entomologist*, vol. xlv., p. 287.)

EXCURSION TO BAGLEY WOOD, BERKS, WEDNESDAY, AUGUST 7TH.

At the kind invitation of the President and Fellows of St. John's College, Oxford, a party of about seventy members of the Congress started at 2.30 p.m. in one of Messrs. SALTER's steamers from Folly Bridge, to visit Bagley Wood, formerly one of the best-known entomological localities in the Oxford district. The bad weather of the "Congress week" was by no means favourable to an excursion of this nature, but the rain fortunately kept off during the trip down the river to Kennington, and the

pretty scenery of the Isis banks was great admired by the visitors. Arrived at the landing-place, a start was at once made for the wood, about a mile distant, the party being under the leadership of the late Mr. G. H. GROSVENOR and Commander J. J. WALKER. It was an unpropitious day for collecting, everything being dripping with moisture, but some of the lepidopterists present made a determined attempt to find something, though scarcely an insect was to be seen on the wing. The only result was one fine fresh *Sarrothripus undulanus* Hübn., beaten out of spruce, and a few Tortrices and Tineæ, including the interesting little *Psoricoptera gibbosella* Zell., found on the trunks of the oaks. Sweeping the herbage at the sides of the wood-paths, before the rain came on, resulted in the capture of one or two not altogether common beetles, such as *Tachyporus formosus* Matt., *Longitarsus lycopi* Foudr., *Orobitis cyaneus* L., *Hylesinus oleiperda* Fab., and a specimen of the well-marked *ab. sublineata* Weise, of *Adalia obliterata* L. A few small *Staphylinidæ* (*Gyrophæna*, *Homalota*, etc.) were found in fungi, and the handsome *Philonthus decorus* Grav. was apparently not uncommon under dead leaves ; while some oak logs near the woodman's house contained *Scolytus intricatus* Ratz. The small amount of work that was possible gave but a poor sample of the well-known entomological riches of this famous wood, and collecting was all too soon at an end, as a heavy downpour of rain drove everybody into such shelter as the thickest available spruce-firs could afford. When the rain abated somewhat, the party adjourned without loss of time to the pavilion in the wood, where tea had been hospitably provided by the President and Fellows of St. John's College. At 6 p.m. a move was made for the steamer, which was reached just in time to escape another tremendous shower, which only ceased just before the party disembarked at Folly Bridge, having spent a pleasant and interesting afternoon despite the adverse meteorological conditions.

THURSDAY, AUGUST 8TH, 10 A.M.

GENERAL MEETING.

President : E. J. G. EVERTS.

Vice-President : A. HANDLIRSCH.

Secretary : H. ELTRINGHAM.

The Secretary announced that the Section of Economics and Pathology, adjourned from the previous day, would sit in Room C, under the presidency of Prof. JABLONOWSKI (cf. p. 77).

That in the Section of Bionomics in Room B that morning, after Prof. WHEELER's paper, Prof. OSBORN would give a paper entitled :

INSECT FAUNA OF A LAKE SHORE.

That in the Section of Morphology that morning, owing to the absence of M. BOUVIER, Dr. SPEISER, as Vice-President, would take the chair.

That in the Section of Nomenclature that afternoon, owing to the absence of Dr. F. A. DIXEY, M. le Dr. OLIVIER would take the chair.

That Mr. E. E. GREEN's paper had been received, though, as Mr. GREEN was unavoidably absent, it would be taken as read.

The Secretary also gave details of the arrangements which had been made for the railway journey to Tring on Saturday.

The President, in a few appropriate remarks, thanked the Committee for the honour they had done him in appointing him President of the meeting, and called on A. HANDLIRSCH to give his paper entitled :

UEBER EINIGE BEZIEHUNGEN ZWISCHEN PALAEONTOLOGIE,
GEOGRAPHISCHER VERBREITUNG UND PHYLOGENIE DER
INSEKTEN.

The holometabolous insects are on the whole less thermophile than the heterometabolous forms. The former are much younger than the latter. The development of holometabolism probably due to a climatic factor. The author demonstrates by a tabular survey that the lower groups of the Heterometabola are more pronouncedly thermophilous than the higher groups, and that, on the contrary, in the Holometabola the lower groups are found in the temperate and cold zones and the higher forms in the warm zones.

Statistic and analytic methods in Zoogeography. An analysis of the genera renders it evident that no close connection has existed between the three continents stretching towards the Antarctic. Maps illustrating alterations in the distribution of land and water since Tertiary times (cf. **Vol. II.**, p. 248).

The lecture was illustrated by lantern slides.

Discussion.

Hon. W. ROTHSCHILD remarked that the marine mammal *Monachus* which occurred in N.W. Africa and the W. Indies, had occurred also in Hawaii, but had now been exterminated.

H. J. KOLBE.—Es ist erfreulich, dass Kollege HANDLIRSCH wieder die statistische Methode einführt, welche genaue Anhaltspunkte liefert, soweit das innerhalb gewisser Grenzen möglich ist. Ferner bemerke ich noch Folgendes. Es giebt manche Familien, Subfamilien und viele Genera von primärer Organisation, welche hauptsächlich die borealen und die moderierten Zonen der Nordhemisphäre bewohnen, z. B. unter den Neuropteren die Sialiden, Raphidiiden, und Trichopteren, dann unter den Coleopteren viele Gruppen der Carabiden, besonders die inferioren Gruppen, auch die Silphiden, Staphyliniden, und andere. Es scheint mir eine Tatsache zu sein, dass Beziehungen bestehen zwischen dem zahlreichen Vorkommen dieser Familien, Subfamilien etc. auf der Nordhemisphäre und der inferioren systematischen Position dieser Insektengruppen. Wir nehmen auf Grund verschiedener Tatsachen an, dass die Zentren der Ver-

breitung der Tiere auf dem grossen zirkumpolaren arktischen Kontinent der geologischen Zeitperioden zu suchen sind. Das ursprüngliche Zentrum der Verbreitung, also die ursprüngliche *Patria* einer Familie oder einer Genus ist nach meiner Meinung dort zu suchen, wo noch jetzt die meisten Subfamilien, Genera, und Spezies dieser Familie leben oder in früheren Zeitperioden gelebt haben. Mit dieser Annahme haben wir einen festen Punkt, der eine Handhabe bietet und von dem wir ausgehen können. Sowohl aus der jetzigen geographischen Verbreitung, als auch aus der inferioren systematisch-phylogenetischen Position schliesse ich, dass die *Patria* der genannten Familien in der zirkumpolaren arktischen Region zu suchen ist.

Ausserdem muss ich hinsichtlich der kontinentalen Verbindungen zur Erklärung der geographischen Verbreitung anführen, dass ich mich mit der allzuweit gehenden Annahme von hypothetischen Landbrücken, wie sie v. IHERING seit mehreren Jahren in seinen wichtigen Büchern und Abhandlungen vorträgt, nicht ganz befreunden kann. Ich habe mich darüber schon in meinen früheren Abhandlungen über diesen Gegenstand ausgesprochen. Ich erkläre die meisten diskontinuierlichen Vorkommnisse vieler Genera durch eine Verbreitung von dem alten arktischen Kontinent aus, teilweise auch durch eine Verbreitung vom antarktischen Kontinent aus, z. B. das Vorkommen der grossen *Felis*-Arten in Amerika, die augenscheinlich von der Osthemisphäre gekommen sind. Allerdings kann man ohne Zweifel zu hegen annehmen, dass die Kontinente teilweise früher weiter ausgedehnt waren, als in der Jetztzeit, z. B. die Westseite Amerikas. Die Fauna der Kordilleren, besonders der Westseite der Kordilleren, sowohl in Nord-, wie in Central- und Südamerika, muss einen weiteren Raum westwärts eingenommen haben als jetzt, um so differenziert werden zu können wie sie ist. Sie ist ganz verschieden von der Fauna der verschiedenen Teile Amerikas östlich von den Kordilleren. Auch spricht die Fauna der Galapagos-Inseln für die westliche Ausdehnung Central-Amerikas. Ebenso ist es beachtenswert, dass die Hawaii-Gruppe eine grosse Anzahl indigener Genera besitzt. Diese sprechen inbezug auf die Möglichkeit ihrer Entstehung und Entwicklung für einen grösseren Raum, sei es eine grosse kontinentale Insel, sei es eine Halbinsel, jedenfalls für eine nähere Beziehung

zu oder eine Verbindung mit einem benachbarten Kontinent. Auch Madagaskar, die Maskarenen und die Seychellen müssen mit Indien, zeitweise und teilweise auch mit Afrika verbunden gewesen sein. Ebenso muss die südasiatische Inselwelt zeitweise irgendwie einen kontinentalen Anschluss an Australien gehabt haben.

Prof. HANDLIRSCH thanked Messrs. ROTHSCHILD and KOLBE for their interesting contributions, which were quite in accordance with his own views.

The President having thanked Prof. HANDLIRSCH for his excellent paper, the meeting divided into sections.

THURSDAY, AUGUST 8TH, 11 A.M.

SECTION I.—EVOLUTION, BIONOMICS, AND MIMICRY.

President : F. D. MORICE.

Vice-President : W. M. WHEELER.

Secretary : K. G. BLAIR.

The President called on Messrs. CRAWLEY and DONISTHORPE to give their paper on :

THE FOUNDING OF COLONIES BY QUEEN ANTS.

In the introduction the authors gave a brief historical survey of the subject from GOULD in 1747 up to the present day, and drew up a new table embracing all the known methods of colony-founding under four main heads, the first being subsequently treated under the title of "Normal Method," and the remaining three under that of "Abnormal Methods."

The Normal Method, colony-founding by a single unaided female, or by two or more in conjunction, is the ancestral method of all ants, and was shown to obtain among the majority of species to-day. The mother-ant feeds her offspring on the secretions of her own body, and takes no food until the appearance of the workers. This period of starvation is rendered possible by the accumulation of body-fat by the female during her larval period, and the absorption of her now useless wing-muscles. The most highly-developed instance of this independent founding is the female *Atta* or fungus-growing ant, who carries on her flight from the parent nest a supply of the fungus sufficient to start a garden for her new colony.

Under Abnormal Methods are included all cases where the female, having lost the power of independent colony-founding, is compelled to seek the aid of workers of another species in bringing up her young. Such cases range from the dominant group of temporary social parasites, through the facultative

and obligatory slave-makers, down to the degenerate permanent parasites.

Theories were discussed and criticised, new ones put forward, and throughout the paper facts were illustrated by the most striking observations and experiments of other myrmecologists and numerous original ones of the authors (cf. **Vol. II.**, p. 11).

Discussion.

W. M. WHEELER asked how males were treated, in reply to which Mr. CRAWLEY stated that as only three males of *Anergates* were obtained, the first taken in Britain, it was considered advisable to preserve them and not to risk them by experiments.

Dr. SHARP suggested that the refusal of queens was probably a matter of taste.

W. M. WHEELER then gave his paper entitled :

OBSERVATIONS ON THE CENTRAL AMERICAN ACACIA ANTS.

Early theories of symbiotic relations of ants and plants. TREUB and RETTIG's researches, showing the independent origin and function of the cavities in epiphytic *Rubiaceæ*. The species of *Acacia* and their distribution. Division of *Acacia* ants into "obligatory" and "facultative." The habits of the obligatory *Pseudomyrmas*. The ants after removing the contents of the thorns take up their dwelling in the hollow so formed. Un-attacked thorns also dry up and become hollow. If the tree be disturbed, the ants emerge and attack the intruder. The founding of colonies of ants in the young *Acacia* trees. Probable coalition of many broods. Different species found associated. Other insects, and sometimes birds' nests found in the *Acacia* plants. Central American and African *Acacia* ants. Leaf-cutting ants not sufficiently formidable to support symbiotic theory of *Acacia* ants. The *Acacia* trees sufficiently protected by their thorns. Less defended species of *Acacia* and *Acacia*-like plants thrive without the presence of ants. Ants have probably become adapted to the *Acacias*, and are parasitic and not symbiotic. Ant-infested *Cecropias* furnish no better support for symbiotic theory. Species of *Triplaris*, a large vigorous tree, unlikely to tempt leaf-cutters, also inhabited by ants which live in the cavities of the branches (cf. **Vol. II.**, p. 109).

Discussion.

Mr. CRAWLEY asked if ants inhabited thorns during winter and summer.

W. M. WHEELER stated that they did so, contrary to BELTS's statement, the colonies becoming one colony.

E. B. POULTON asked if food bodies existed, and W. M. WHEELER replied that in the E. Indies they did, but were not always visited.

In reply to a question by H. SKINNER, W. M. WHEELER said that animals were not deterred by ants, sloths having been observed to feed on them.

P. P. CALVERT said that in one and the same locality (Turrucares) in Costa Rica, he had observed *Pseudomyrma* on the Acacias in August, December, and April, consequently in quite different seasons, wet and dry.

H. SCOTT asked if anything were known as to what proportion of *Cecropia* trees were inhabited by ants, and if that proportion varied in different countries where the *Cecropia* tree occurred.

W. M. WHEELER replied that the same species of *Cecropia* can be inhabited by ants in one district and not in another, and instanced Porto Rico, in which island no ants at all were found in the *Cecropia* trees.

H. OSBORN then gave his paper entitled :

INSECT FAUNA OF A LAKE SHORE.

(No manuscript received.—EDITORS.)

Discussion.

H. SCOTT asked if any adaptations of Caddisfly larvæ (*Trichoptera*) to living in the wave zone, such as had been observed in Denmark, had been found, in reply to which Prof. OSBORN stated that none had been observed, and that the waves were too violent and the shore too sandy and shifting for any considerable number of Caddisfly larvæ to inhabit it.

The meeting then rose.

THURSDAY, AUGUST 8TH, 11 A.M.

SECTION II.—MORPHOLOGY AND ANATOMY.

President : E. L. BOUVIER.

Vice-President : P. SPEISER.

Secretary : G. MEADE-WALDO.

In the absence of M. BOUVIER, Dr. SPEISER took the chair. The Vice-President in opening the meeting called on Mr. FREDERICK LOWE to give his paper on :

THE DEVOLUTION OF WING STRUCTURES AS SHOWN IN THE
BLATTIDÆ.

(No manuscript received.—EDITORS.)

Discussion.

P. SPEISER dankt Mr. LOWE für die interessanten Mitteilungen und weist darauf hin, dass die Variabilitätskurve einen besonders steilen Anstieg und Abfall hat.

A. v. SCHULTHESS dankt dem Vortragenden gleichfalls für die grosse Mühe, der es sich bei einer solch ausgedehnten Untersuchung unterzogen hat. Er macht darauf aufmerksam, dass auch andere Othopteren, z. B. *Pezotethis*, in bezug auf Länge und Breite der Flügel sehr variabel sind, besonders auch in der Länge resp. dem allmählichen Verschwinden der Falten des Hinterflügels. Ferner ergänzt er Mr. LOWE's Angaben über die Verbreitung der besprochenen Arten.

A. HANDLIRSCH erinnert daran, dass die Variabilität der Flügel eine den Blattiden seit jeher zukommende Eigenschaft ist ; denn schon unter den Carbon-Blattiden ist es nicht möglich, auch nur zwei gleiche Flügel zu finden. Tiefstehende, wenig spezialisierte Formen sind im allgemeinen mehr variabel als hochspezialisierte.

P. SPEISER weist darauf hin, dass die Kongresse die beste Gelegenheit bieten, durch persönliche Aussprache von Biologen,

Statistikern, Geographen, und Palaeontologen eine wissenschaftliche Frage oder Disciplin zu fördern. Er gedenkt bei dieser Gelegenheit SHELFORD'S, der viel über Blattiden veröffentlicht hat und vor wenigen Wochen verstorben ist.—Die Mitglieder der Sektion ehren sein Andenken durch Erheben von den Sitzen.

J. VAN BEMMELEN asked if Mendelian research would not lead to clearer results, as it was obvious that the form and size of the wings depended on certain units present from remote times.

C. J. GAHAN remarked that the *Blattidæ* did not lend themselves well to Mendelian research, owing to the length of time they individually took to reach maturity.

T. A. CHAPMAN then read his paper on :

SOME EXPERIMENTS ON THE REGENERATION OF THE LEGS
OF *LIPARIS DISPAR*.

The lecturer described his experiments on the results to the imago of amputating portions of the appendages of the larvæ of *L. dispar* and *A. pronuba*, and stated that he had found anæsthesia produced by drowning caused much less inconvenience to the subject than chloroform. Numerous photographs were shown depicting the results of the experiments, and the following conclusions were drawn :

(1) That unless a very radical removal of the leg had been made, regeneration always took place. Variation in the results in different instances of the same injuries at the same stage might be due to a difference in vital stamina, to some local injury accompanying the operation, or to some abortive septic attack which had the effect of merely weakening the tissues involved.

(2) There was always some effort at regeneration, but its completeness depended largely on the number of moults after the injury.

(3) Regeneration was simple after a clean amputation, but branching or duplication might result from crushing of the part.

(4) Regeneration was much more rapid in some species than in others (cf. **Vol. II.**, p. 295).

Discussion.

P. SPEISER said he wished to convey to Dr. CHAPMAN the thanks of the meeting for his interesting and laborious investiga-

tions. He was astonished that there should be so complete a regenerative power in an insect so highly specialised as *L. dispar*.

No discussion ensued, and the meeting terminated.

THURSDAY, 11 A.M.

SECTION III.—ECONOMIC AND PATHOLOGIC.

[Adjourned from Wednesday ; the same officers.]

For report on this continuation of adjourned Wednesday meeting cf. p. 79.

THURSDAY, 2 P.M.

SECTION I.—NOMENCLATURE.

President : F. A. DIXEY.

Vice-President : E. OLIVIER.

Secretary : K. JORDAN.

As Dr. F. A. DIXEY was unavoidably prevented from attending the meeting, Dr. E. OLIVIER took the chair and called upon Dr. W. HORN to present his protest against the admission of exceptions from the law of priority.

W. HORN's "Protest gegen die Zulassung von Ausnahmen vom Prioritätsgesetz" richtet sich hauptsächlich gegen den von der Deutschen Zoologischen Gesellschaft ausgehenden Angriff. Er weist auf die Unzuträglichkeiten und Gefahren hin, welche die Annahme der Vorschläge mit sich bringen würde, und kritisiert das von Prof. BRAUER, dem Schriftführer dieser Gesellschaft, versandte Flugblatt (cf. **Vol. II.**, p. 158).

A discussion ensued in which many of those present took part, while others showed their lively interest by acclamation.

E. OLIVIER.—Je crois que M. HORN a été plus loin que la pensée du professeur BRAUER relativement aux publications auxquelles il faut dénuer tout caractère scientifique. On ne doit certainement attribuer aucune valeur aux journaux publiques, à certaines publications agricoles, et à des catalogues de vente où se trouvent parfois en note des descriptions sommaires d'espèces ou de variétés. Mais il me semble impossible de ne pas accorder l'autorité qu'ils méritent à l'Encyclopédie Méthodique et aux dictionnaires absolument scientifiques qu'a cités M. HORN. D'autre part, MOTSCHOUISKY, MÉNÉTRIÉS, entre autres notables entomologistes, ont rédigé des catalogues où se trouvent des descriptions dont il faut absolument tenir compte.

Hon. L. W. ROTHSCHILD said that, although himself an uncompromising supporter of strict priority, he should be willing

to agree to a new priority law such as Mr. WHEELER'S, if means could be devised to prevent confusion arising out of the admission of exceptions. He was afraid that the list of exceptions would be never-ending. He also thought that the appendices to books on travel must not be treated as outside priority; for it often occurred that travellers insisted on them, as the scientific appendices assured the books a larger sale. Moreover, it would be hard on the explorer if the lists of his discoveries appended to his book were considered as nomenclatorially non-existent.

E. HARTERT entirely agreed with Dr. HORN'S protest and drew special attention to the incredible proposal to augment and enlarge the lists of names and books which are now proposed to be "indexed."

H. J. KOLBE beklagt, dass die Prioritätsgesetze, welche so viel Ärger, Konfusion, Konflikte, und Misverständnisse zur Folge gehabt haben, überhaupt existieren. Sie hätten nie aufgestellt werden sollen. Da sie nun einmal bestehen, müssen wir versuchen, mit ihnen fertig zu werden. Jedenfalls könnte hier das alte deutsche Wort Anwendung finden "Keine Regel ohne Ausnahme." Machen wir also Ausnahmen. Die gewöhnlichsten Namen, welche in forstwissenschaftlichen und landwirtschaftlichen Werken und in der Schul-Literatur seit alten Zeiten in Gebrauch sind, sollten konserviert werden. Eine Ersetzung dieser Namen durch andere sollte unzulässig sein.

W. HORN macht auf den Widerspruch aufmerksam, dass im Interesse der forstzoologischen etc. Literatur gewisse Namen geschützt werden sollen und dass gleichzeitig gesagt wird, dass landwirtschaftliche Publikationen nicht prioritätsberechtigt sein sollen.

G. WHEELER supported Dr. HORN'S suggestion, but thought he had given too wide a signification to the Catalogues and Dictionaries which were to be rejected. He quite agreed that lists of exceptions could not be admitted, but maintained that a definition of the words "name" and "available" would work automatically, and that the Law of Priority thus restricted by definition could be applied strictly.

W. W. FOWLER said that things are best left where they are, except for the elimination of names that are manifestly absurd and transgress common sense. At present the *Zoological Record*

keeps things up to date and misses very few, if any, species, even though described in obscure publications.

E. M. DADD remarked that Dr. HORN had put too wide a construction on the German proposals. Their chief desire was to restrict publication of new descriptions in unscientific publications. Under catalogues they chiefly had in view the publication of names (without description) in price-lists, as has frequently been done in STAUDINGER's price-lists.

He should favour the suggestion of Mr. WHEELER that a time-limit be fixed, whether twenty-five or fifty years was immaterial. The continued change of names was more serious from the point of view of applied Entomology, as for instance in medical Entomology. A change of name would not be followed by any one not being an entomologist, although the systematists might be able to adapt themselves to any change.

E. HARTERT said that Dr. HORN was perfectly right to base his protest on what was said in the proposal of the German Zoological Society, and not on what was perhaps meant. Nobody speaks of *continual* changes ; a change to the actually oldest name was one change, and the changing of the name could not be continued.

G. WHEELER remarked : the instance given was just a case in point. We had been told to change *Colias edusa* to *Eurymus croceus* and then to change it back again.

A. SEITZ berichtet, dass die Vorarbeiten über eine Verständigung in der Nomenklaturfrage aus dem Jahre 1891 stammen, wo von der Deutschen Zoologischen Gesellschaft diese Arbeiten beschlossen wurden und eine Kommission aus fünf Mitgliedern eingesetzt wurde, bei der *kein Entomologe* war. Erst später wurde BRAUER (Wien) coadoptiert, starb aber bald. Es ist also von vornherein zu erwarten gewesen, dass die von dieser Seite gemachten Vorschläge nicht von der internationalen Entomologie würden angenommen werden. Da nun aber Proteste die Sache nicht weiterbringen, so wäre vielleicht zu versuchen, sich mit der Zoologie zu einer gemeinsamen Kommission zu vereinigen, bei der die Mitgliederzahl aber der Zahl der von beiden Parteien zu vergebunden Namen entsprechen müsste (so dass jedenfalls die Entomologen nicht in der Minderzahl wären).

Hon. W. ROTHSCHILD said that Dr. SEITZ's request would

be included in the suggestion to be brought forward by the Executive Committee in the General Meeting on Friday.

G. SEVERIN traduit en français la proposition du professeur SEITZ, qui propose de nommer une commission d'accord avec la Commission Internationale de Zoologie pour étudier les règles de la nomenclature et notamment la loi de la priorité et les lois d'exceptions, en exigeant un nombre de voix au moins égal à ceux des zoologistes, vu le nombre d'insectes plus considérable que celui de tous les autres animaux.

Il ajoute qu'il lui semble que le Congrès d'Entomologie peut aller plus loin et demander une sorte d'autonomie qui lui permettra de faire étudier toutes les questions importantes de nomenclature par son comité international, lequel se mettra ensuite en rapport avec le comité zoologique pour faire accepter ou discuter ses vues.

CHAS. KERREMANS then read his paper entitled :

LES VARIÉTÉS DOIVENT-ELLES ÊTRE NOMMÉES ?

Varietal names often given for reasons other than scientific interest, such as personal pride, desire to possess types, etc. What one author regards as a species, another may only term a variety. Though names must be given to genera and species, it seems unnecessary to name mere varieties, since no two individuals are absolutely alike. The study of variation is necessary and interesting, but is it necessary to name all the stages of variation ? The difficulty illustrated by instances of the great variability in various species of *Buprestidæ*. Of *Stigmodera variabilis*, for instance, he had seen thousands of examples no two of which were alike. He appealed to the Congress to consider the matter and find a remedy for the excess of nomenclature which threatened to become an abuse (cf. **Vol. II.**, p. 187).

Hon. W. ROTHSCHILD said that, although an abuse had been made of naming aberrations, as such aberrations had become of interest in biology, they ought to bear names in order to make reference to them easier.

ED. EVERTS gave as an example *Coccinella bipunctata*, which varies from red to black, one form being red with two black dots and another extreme black with two red dots. Both forms bear names, the latter aberration being ab. *bimaculata*. It was cer-

tainly better to use names than numbers, as it was impossible to work with numbers in cases of very variable species.

CHAS. KERREMANS.—Je suis parfaitement à l'aise pour répondre à mon honorable collègue et ami M. EVERTS. Certes, il existe des variations infinies chez certaines espèces, mais si ces variations peuvent être indiquées dans les descriptions est-il nécessaire de les nommer ? Ce n'est, après tout, qu'une appréciation personnelle, un vœu de voir disparaître l'abus des noms, que je propose, sans vouloir l'imposer.

E. OLIVIER.—La simplification proposée n'est pas très facile à appliquer. On peut très bien ne plus décrire de variétés dans les espèces paléarctiques, qui sont à peu près toutes bien connues. Mais il n'en est pas de même des exotiques, et un entomologiste qui n'a sous les yeux que deux individus lui paraissant dissemblable leur imposera à chacun un nom, et ce n'est que plus tard, quand il aura pu en observer une longue série, qu'il reconnaîtra que ses deux prétendues espèces ne sont que des types extrêmes de la variété d'un même type.

A. T. CHAPMAN.—The only real remedy for the great abuse of aberrational names was to put them altogether outside any claim to permanence, that was to protection by the law of priority, which is at present accorded them in practice. This would result in naming for the sake of naming being discouraged, and the field would be free to actual students of any group to apply descriptive aberrational names to any forms that it was desirable to recognise for questions of variation, phylogeny, etc. Such names given by specialists would survive entirely in accordance with their usefulness.

W. ROTHSCHILD said that the suggestion of Dr. CHAPMAN was met by one of the nomenclatorial rules of the International Commission, but he thought they ought to have a special rule of their own in view of their new importance in biology and bionomics.

E. HARTERT thought that with aberrational names it was not a question of priority, because the same names were used many times within the same genus, and therefore could not have any nomenclatorial standing.

L. NAVAS.—Je conserverais les noms *vrais* (qui ne soient pas des simples synonymes) des variétés et même des aberrations.

Souvent ils disent beaucoup plus que les numéros, p.e. *nigra*, *algerica*, *italica*, etc. Les numéros seuls pourront être utiles pour une monographie *complète*, p.e., d'un genre ou d'une espèce ; mais si on trouve une *autre* forme il faudra l'intercaler et alors il y a un changement continu des numéros. Les noms ne changent pas.

Il peut arriver aussi qu'une variété plus étudiée passe au rang d'espèce, ou, au contraire, une espèce descende au rang de variété ou d'aberration ; son nom une fois publié reste fixe. Le nombre trop grand de noms n'est pas un grand inconvénient, pourvu que dans l'état actuel de la science ces noms doivent passer aux mains des spécialistes, qui doivent connaître bien les espèces et les variations. Pour les débutants il leur suffira d'en voir les noms spécifiques ou des genres.

P. SPEISER bemerkt, dass die Namen nur als Vokabeln dienen und wir brauchen sie, um damit bei unsern Untersuchungen kurz und präzise das Gemeinte zu bezeichnen. Es erfordert zuviel geistige Arbeit, wenn z. B. in einer Untersuchung über Vererbung alle Formen nur mit Buchstaben oder Nummern bezeichnet werden ; Namen sind viel besser im Gedächtnis zu behalten. Es kommt auch in Betracht, dass einzelne Buchstaben leichter irrtümlich verdruckt oder verschrieben werden können, als ein Name. Auch können Varietäten einer Art zu einer andern geschoben werden müssen ; der Name bleibt, der Buchstabe würde Schwierigkeiten machen. Daher bin ich aus praktischen Gründen dafür, Namen beizubehalten und nicht Buchstaben einzuführen.

The third paper of the programme was then read (E. OLIVIER) :

NECESSITÉ DE L'EMPLOI DU LATIN POUR LES DESCRIPTIONS.

Detailed descriptions in the language of the author should be preceded by a short description of the essentials written in Latin, thus enabling any one rapidly to decide whether an insect is likely to be that which is later described in greater detail. The large number of scientific publications in all languages makes it impossible for any one to be able to read them all. Appeal to German, English, and French entomologists to set the example

by prefacing their descriptions with a short diagnosis in Latin (cf. **Vol. II.**, p. 232).

L. NAVÁS.—Je n'admettrais pas de l'Esperanto, parceque :

(1°) Il ne faut pas surcharger les entomologistes, qui sont déjà trop encombrés ;

(2°) L'Esperanto est encore peu connu dans le monde scientifique ;

(3°) Il n'est pas encore bien fixe ou universelle. Peut-être il se modifiera ou tombera.

G. HORVÁTH.—Il serait à désirer que la proposition de M. OLIVIER soit adoptée à l'unanimité par le Congrès. La rédaction des diagnoses latines n'est pas aussi difficile qu'on pouvait le supposer, puisqu'il ne s'agisse d'habitude que de 80 ou 100 mots latins au plus qu'on doit connaître, et la composition des phrases est des plus simples. On peut s'exprimer dans ces diagnoses latines d'une manière beaucoup plus claire, plus nette et plus exacte que dans n'importe quelle langue vivante.

THURSDAY, 2 P.M.

SECTION II.—ECONOMICS AND PATHOLOGY.

President : G. HEWITT.

Vice-President : V. FERRANT.

Secretary : H. ROWLAND-BROWN.

The President called on Prof. FORBES to give his paper entitled :

THE *SIMULIUM*-PELLAGRA PROBLEM IN ILLINOIS.

Investigation of pellagra in the insane asylums and other institutions of Illinois. Dr. SAMBON's theory of the transmission of pellagra by *Simulium*. Collecting, breeding, and observing *Simulium* in Illinois ; results different from those of SAMBON. Relation between the waves of increase of the disease and the appearance of the imagines of *Simulium* very doubtful ; the observations in Illinois not plainly conclusive either for or against the *Simulium* hypothesis (cf. **Vol. II.**, p. 477).

Hon. N. C. ROTHSCHILD asked Prof. FORBES if he had observed in Illinois the fact—which had been noted in Hungary—that pellagra was essentially a disease of the poor. He also added some remarks as to the distribution of the disease in Hungary, where it was very local.

F. A. LOWE remarked that the bed-bug was a suitable insect for experiment in the transmission of disease. It was easily manipulated in the laboratory, very long-lived, and could be secured in numbers the whole year round.

R. NEWSTEAD regretted that no incriminating evidence had been obtained. He suggested that entomologists should continue their researches on the admissible lines which had been demonstrated by the lecturer.

L. O. HOWARD congratulated Prof. FORBES on the interesting and important results of his investigations. He had little confidence in the truth of SAMBON's theory, which was based entirely on a series of apparent coincidences. He stated that

investigations were now being carried on in the state of S. Carolina by the U.S. Public Health Service and the Bureau of Entomology at Washington working in co-operation, and that the entomologists engaged on this work were studying not only the distribution of *Simulium*, but the character and habits of all biting insects in pellagra centres.

M. ANDRES said that Dr. SEEBOHM, who had travelled in Egypt, had not, so far as he knew, found *Simulium* in Lower Egypt, where however the pellagra disease was very common. He thought he had found this fly only in Upper Egypt.

H. SKINNER suggested the necessity of studying the individual distribution of cases of pellagra with a view to discovering whether proximity were a factor, or played any part, in the distribution.

IVAR TRÄGÅRDH said that in Sweden, where, especially in the northern part, *Simulium* was very common, pellagra was an unknown disease.

F. A. LOWE then read a paper entitled :

HOW TO KILL THAT FLY.

(No manuscript received.—EDITORS.)

A. BACOT drew attention to the necessity of taking into account, by sanitary authorities, the relation of temperature to the length of life cycle in *M. domestica*, and the consequent need for the collection of rubbish at shorter intervals than fourteen days during the summer months.

H. SKINNER remarked that the house-fly was a disgrace to humanity, and that the problem had been solved in civilised communities. It was necessary to remove and destroy the effete material in which the larvæ lived.

The meeting then terminated.

Sir N. J. MOORE intended to read in this Section a paper on
RECENT WORK IN ECONOMIC ENTOMOLOGY CARRIED OUT IN
WESTERN AUSTRALIA;

but was unavoidably prevented from attending the Congress. The paper is printed in **Vol. II.**, pp. 221-226.

FRIDAY, AUGUST 9TH, 10 A.M.

SECTION I.—EVOLUTION, BIONOMICS, AND MIMICRY.

President : V. KELLOGG.

Vice-President : A. GROUVELLE.

Secretary : H. H. DRUCE.

R. C. PUNNETT, on behalf of Mr. J. C. F. FRYER, communicated a paper on :

THE POLYMORPHISM OF *PAPILIO POLYTES*.

(No manuscript received.—EDITORS.)

After reading the paper Prof. PUNNETT said that the proportion of the several forms of female suggested a population in equilibrium. This he regarded as pointing to there being an absence of discriminating selection going on amongst the three forms of female of *Papilio polytes*.

J. C. H. DE MEIJERE stated that he had occupied himself with studying the experiments of Mr. JACOBSON on *Papilio memnon*. There was an agreement in so far as there also the non-mimetic form was the only one which would produce that form exclusively. He congratulated Mr. FRYER and Prof. PUNNETT on the results obtained. On the other hand, in *P. memnon* there seemed not to occur simple sex-limited inheritance, because in that species none of the female forms were quite like the male.

C. ANNANDALE congratulated Mr. FRYER on attacking so important a problem in the tropics, and not on a hurried expedition. He also pointed out the possible importance of environment on the suppression of the ova at a comparatively early stage, and also the possibility that ova with certain fundamental characters were more easily suppressed than others.

Hon. W. ROTHSCHILD said that the question of fish fertility in relation to food, as raised by Dr. ANNANDALE, was vitiated by the experience of the naturalists of Bonn, between the years

1884 and 1889, viz. that in salmon in the Rhine, when prevented, through shoal water or shifting gravel, from laying their eggs, the spawn was retained in the body, and embedded in fat, so that the female salmon in question became absolutely sterile.

E. B. POULTON said that Mr. FRYER must be congratulated on his success in the difficult task of breeding *P. polytes* through a series of generations, and on the interesting results he had obtained thereby. The speaker was unable to accept the conclusion that the proportions of the different female forms of the species were determined by the Mendelian relationship unaffected by selection. Geographical changes in the mimetic female forms of *P. dardanus* followed the presence or absence of various Danaine models, as he had described and illustrated in his introductory address. No hypothesis except selection had been suggested to account for the phenomena exhibited by *P. dardanus*, and he should find it very hard to believe that proportions of the females of *polytes* were determined by an entirely different principle. He had, in fact, been told at that very meeting, by Dr. ADALBERT SEITZ,¹ that the excessive rarity (very rarely amounting to entire absence), of the chief *Papilio* model at Hongkong was accompanied by an equal rarity of the corresponding mimetic female. Furthermore Mr. W. ROTHCHILD and Dr. KARL JORDAN had shown that geographical change in the amount of white in the hindwing of this model was also found in the pattern of the mimicking female.

C. ANNANDALE pointed out that Prof. POULTON's instances of work done on encouragement from the Hope Department actually bore out his view that it was important that zoological work should be done in the tropics. He realised the great help given by the Oxford Museum to workers in the tropics, and maintained that there was a strong feeling in some museums that zoologists in the tropics should act merely as collectors.

T. A. CHAPMAN said that, in reference to Dr. ANNANDALE's remarks on fertility in captivity, an observation on *Acronycta alni* some twenty years ago showed that bred specimens, not related, would pair freely, but no eggs were laid, but in all instances—some five or six—in which a wild male was obtainable, pairing

¹ Dr. SEITZ's observations are now recorded in full in *Proc. Ent. Soc. Lond.*, May 7th, 1913.

was followed by the laying of fertile eggs. The explanation was not obvious.

Hon. W. ROTHSCHILD remarked that in those parts of the range where the *Pharmacophagus* model was devoid of white, the *polytes* mimetic females were also devoid of white.

Hon. N. C. ROTHSCHILD asked Prof. PUNNETT if Mr. FRYER meant by sterility that no eggs were laid or that those deposited were unfertile.

A. BACOT said that in the case of fleas, by careful adjustment of conditions, they had been able to obtain 80 per cent. to 100 per cent. of fertile ova from *Ceratophyllus fasciatus* and *Xenopsylla cheopis*; but so far had not been able to get a higher percentage than fifty to seventy of fertile ova from *Pulex irritans*. This could only be attributable to difference in feeding. Whilst the two rat fleas had unlimited opportunities for feeding, the *P. irritans*, owing to lack of time, did not get more than fifteen minutes daily to imbibe.

E. B. POULTON then communicated a paper by Mr. C. F. M. SWYNNERTON on :

PELLETS EJECTED BY INSECT-EATING BIRDS AFTER A MEAL OF BUTTERFLIES ;

and exhibited the pellets referred to, together with set examples of the butterflies named.

In the pellets of birds fed on Lepidoptera the remains of these insects were only to be found by minute microscopical search (cf. Vol. II., p. 351).

R. NEWSTEAD asked if Prof. POULTON could state what was the period between the taking of food and the casting of the pellet in insectivorous birds. He added that, in his experience, he had not found the remains of butterflies amongst the food contents of British birds, though an abundance of many other groups of the Insecta was discoverable. He called attention to the fact that swallows, the Butcher Bird, *Lanius excubitor*, and *Larus ridibundus* all cast pellets in the same manner as the hawks and owls.

A. SEITZ bemerkte, dass es erwiesen sei, dass Vögel Tagfalter

anfallen. Er selbst beobachtete das u. a. bei *Merops apiaster*. Aber die Zahl der Individuen sei gewiss zu gering, als dass man dem einen schöpferischen Einfluss auf die Resultate der Natürlichen Zuchtwahl zusprechen könnte. Sie kämen nicht in Betracht im Vergleich mit den Milliarden von Fröschen, Kröten und insektenfressenden Reptilien.

E. M. DADD said that predaceous spiders must also be regarded as most serious enemies to butterflies. He had noticed that the butterflies frequently fell victims to flower-haunting species. Species of *Mantis* also accounted for many butterflies.

C. G. HEWITT said that it was possible to detect the presence of lepidopterous adults in the stomachs of birds provided the examination was made shortly after the birds had fed. Such an examination could, however, only be satisfactorily made by means of a binocular microscope.

J. VAN BEMMELEN said that butterfly wings of different kinds were found on the margin of the crater of the Bromo volcano in Eastern Java, evidently bitten off by a hawk circling round, and numerous butterflies were seen flying up the slopes of the volcano and disappearing into the crater.

G. B. LONGSTAFF remarked that it was well known to lepidopterists that butterflies, especially *Papilionidæ*, had a habit of frequenting the tops of hills, whether volcanic or otherwise.

Prof. POULTON replied that the interval between taking food and casting the pellet probably varied greatly in the different species of insectivorous birds. He looked forward to the publication of Mr. SWYNNERTON's detailed observations, which he was sure would throw much light on this as well as many other sides of the question. Mr. SWYNNERTON had informed him that insectivorous birds as a rule digest with great rapidity.¹

A paper by M. PIC was announced entitled :

LE MÉLANISME CHEZ DIVERS CRYPTOCEPHALUS PALÉARCTIQUES, and taken as read (cf. Vol. II., p. 245).

¹ See C. F. M. SWYNNERTON's paper, "Remarks on the stomach-contents of Birds," published since the meeting of the Congress, in *Ibis*, October 1912, p. 635.

A. H. HAMM then exhibited a series of beautiful photographs of insects in resting attitudes in their natural surroundings, giving many interesting details of the habits of the specimens shown.

The photographs, some sixty in number, comprised slides illustrating the following common butterflies: *P. brassicae*, *P. rapæ*, *P. napi*, *E. janira*, *E. tithonus*, *C. pamphilus*, *C. phlæas*, *L. icarus*, and *A. thaumas*. They were all obtained in the neighbourhood of Hogley Bog, Cowley, near Oxford, during the phenomenal summer of 1911, from July to August, between 7 and 8.30 p.m. Each photograph showed the insect exactly as found on the site selected by it for its rest during the ensuing night. The remarkable protective value of the site chosen was not less noticeable than the consistency of attitude assumed. *P. rapæ* almost invariably chose a light background such as the silvery underside of a bramble leaf. On three out of four consecutive nights, the same place on the same upturned bramble-leaf was selected. Other sites chosen included flowering Angelica, leaves of Silver-weed, stems of thistles, leaves and stems of Flea-bane, and often the underside of alder leaves. It was frequently found resting in company with two or more of its own species, or in close proximity to *P. napi*. The latter species, and also *P. brassicae*, chose positions in marked contrast to *P. rapæ*, grass stems being often selected, or various low plants, rarely higher than two feet from the ground.

Several excellent photographs of *E. janira* were shown, illustrating the more highly cryptic underside of the female, as compared with that of the male, the dark basal and lighter distal portions of the wing having an obliterating effect. One male example showed the use of the eye-like spot near the tip of the forewing, a marking long regarded by Prof. POULTON as having a directive value in case of attack. A large tipulid collided with the butterfly, the latter immediately raising the forewing and displaying the ocellus. Before it had resumed the normal position it was successfully photographed.

A series of photographs of *L. icarus* at rest on a variety of low plants and rushes showed a remarkable consistency of attitude, for the insect invariably rested head downwards, with the body in a vertical position. When disturbed it immediately

dropped to the ground, and when the supposed danger appeared to have passed, crawled up again, turned over, and resumed its normal posture.

C. phlæas was found to have somewhat similar habits, though the inverted position was not always adopted, and when alarmed it did not fall to the ground, but raised the forewing so as to display its eye-spots.

Several pictures of the Hesperid *A. thaumas* showed that this species always rested with the body perfectly horizontal and almost invariably chose the ripe seed-head of the buttercup or plantain.

Prof. NEWSTEAD complimented the exhibitor on the great excellence of the photographs, and Prof. KELLOGG also expressed his high appreciation of their beauty and interest.

The meeting then terminated.

FRIDAY, 10 A.M.

SECTION II.—SYSTEMATICS.

President : N. BANKS.

Vice-President : A. V. SCHULTHESS.

Secretary : J. E. COLLIN.

The President, after opening the meeting, called on Baron K. VON ROSEN to give his paper :

ÜBER FOSSILE TERMITEN.

Verfasser gibt eine Zusammenstellung der bis jetzt bekannt gewordenen fossilen Termiten und beschreibt eine Anzahl neuer Arten und Gattungen. Kurze Übersicht der Bernstein- und Kopaltermiten. Verbreitung, Lebensweise.— Illustrated (cf. **Vol. II.**, p. 318).

H. J. KOLBE erinnert an *Termopsis* des Bernsteins, von der HAGEN angiebt, dass diese in Europa ausgestorbene Gattung jetzt noch in Californien lebt. Auf Anfrage erwidert VON ROSEN, dass die Bernstein-Gattung von der californischen verschieden sei.

A. HANDLIRSCH dankt Herrn Baron VON ROSEN für seine überaus interessanten Mitteilungen und beglückwünscht ihn zu den ausserordentlich gelungenen Photographien.

P. SPEISER then read his paper entitled :

BEMERKUNGEN UND NOTIZEN ZUR GEOGRAPHISCHEN VERBREITUNG
EINIGER BLUTSAUGENDEN INSEKTEN.

Verbreitung von blutsaugenden Insekten abhängig von der Verbreitung der Wirtstiere ; historisches Bild oft durch Verschleppung gestört. Genaue Aufzeichnungen wichtig (cf. **Vol. II.**, p. 205).

H. J. KOLBE macht eine Bemerkung zu der Parallele des

Vorkommens von *Glossina* in Afrika und nur noch einer fossilen Art in Nord-Amerika. Es giebt eine kleine Gruppe von Coleopteren, nämlich die *Edrotinen* (*Tenebrionidæ*) mit den beiden Gattungen *Edrotes* in Californien und *Epiphys* in Süd-West. Afrika, die beide noch existieren.

A. HANDLIRSCH weist darauf hin, dass die grossen Saurier im Jura gelebt haben, aber nicht im oberen Tertiär, dass also zwischen *Glossina* und Sauriern keine Beziehung bestehen könne, da sie durch viele Millionen Jahre von einander geschieden sind.

E. TRÄGÅRDH richtete an den Vortragenden die Frage, ob er bei seinen Betrachtungen die Möglichkeit erwogen hat, dass die Insekten, welche jetzt Blut saugen, früher auf Pflanzennahrung angewiesen waren, und weist auf derartige Verhältnisse in Lappland hin, wo blutsaugende Mücken nicht ausreichende Gelegenheit finden, Blut zu saugen.

F. WICHGRAF erwähnt als paralleles Beispiel zu den blutsaugenden Mücken Lapplands, dass ein Herr, der lange in Indien gelebt, die Beobachtung gemacht hat, dass Mosquitos mit Vorliebe auf den giftigen Blättern der Mangrovebüsche sich niederliessen und daran sogen. Er schrieb die besonders bösartige Wirkung ihres Bisses diesem Umstande zu.

Dr. SPEISER further read a second paper :

ÜBER DIE GEOGRAPHISCHE VARIABILITÄT AFRIKANISCHER
BOMBYLIDEN.

(No manuscript received.—EDITORS.)

No discussion ensued, and Dr. CALVERT then read a paper entitled :

PROGRESS IN OUR KNOWLEDGE OF THE ODONATA FROM
1895 TO 1912.

Morphology of the abdomen and its terminal parts. HEYMONS'S demonstration of the existence of twelve segments in the young larva. Mating positions and structures. TILLYARD'S investigations. Copulatory apparatus of the males. The in-

vestigations of GODDARD, THOMPSON, and BACKHOFF. Structure and location of penis. The ovipositor, its development and reduction. Researches of VAN DER WEELE and TILLYARD. Wing venation. The work of COMSTOCK and NEEDHAM. Larvæ. Respiratory and digestive functions. Length of larval life. BALFOUR BROWNE'S work thereon. Number of moults inconstant. Duration of larval instar very variable. Larval peculiarities. OSBURN'S demonstration of their inability to become adapted to saline solutions. Agrionine larvæ living in small accumulations of water at leaf-bases of plants. Mud-dwelling larvæ. Taxonomy. Fossil Odonata. The work of HANDLIRSCH. Faunal studies. Conclusion (cf. **Vol. II.**, p. 140).

G. H. CARPENTER expressed the thanks of the meeting to Dr. CALVERT for the wide summary comprised in the paper, and hoped that other specialists would follow the author's example at future meetings of the Congress.

GORDON HEWITT thanked Dr. CALVERT for his admirable review. He was especially interested in the reference to the varying number of larval stages in a single species, and believed that, as the life histories of insects were more carefully studied, we might have to modify our ideas regarding the fixity of the number of larval stages or ecdyses.

R. S. BAGNALL was to have read a paper on the Order Thysanoptera and other kindred subjects, but was prevented from being present. His specimens were however exhibited later in the afternoon, when he was able personally to demonstrate them to an interested and appreciative audience.

E. L. BOUVIER was prevented by illness from attending the Congress. His paper entitled

LE STADE NATANT OU PUÉRULUS DES PALINURIDES

was taken as read (cf. **Vol. II.**, p. 78).

FRIDAY, 2 P.M.
GENERAL MEETING.

President : E. B. POULTON.

Vice-President : H. J. KOLBE.

Secretary : M. BURR.

To the great satisfaction of his many friends, Dr. MALCOLM BURR was present, and able to take his place as Secretary.

The President called on Dr. ADALBERT SEITZ to give his paper entitled :

ON THE SENSE OF VISION IN INSECTS.

Description of experiments with paper models of butterflies. *Anthocharis charlonia* saw and recognised models of its own female from a distance of eight feet. Models of other butterflies were not attractive. Differences in size were appreciated. The sense of smell was not in this case operative. Models turned round so as to face in another direction showed that the males could recognise orientation. Efforts to pair with paper models showed that the males were not assisted by the sense of touch, a conclusion supported by the fact that when the wind caused the paper-wings to flutter against them, they became more insistent. Butterflies not disturbed by movement of natural objects such as leaves and grass, but alarmed at approach of net, etc., showing that they can recognise form. Experiences showing that butterflies (*Catopsilia phileia*) were able to recognise red from a greater distance than blue. Insects apparently unable to distinguish absence of ultra-violet rays. Very little known concerning the physiology of vertebrate vision.

The President thanked Dr. SEITZ for his interesting paper, and called on Prof. KELLOGG for his paper :

DISTRIBUTION AND SPECIES-FORMING AMONG ECTOPARASITES.

(The paper is printed elsewhere.—EDITOR.¹)

Systematic position of the *Mallophaga*. Structure and life-history. Owing to conditions of comparative isolation there is an absence of the work of external influence, promoting wide divergence, generic and family distinctions thus tending to be few, whilst specific and varietal differences are numerous. Review of the orders of birds, with the numbers of their mallophagan parasites. Tendency of a single parasite species to be common to two or more related host species. Evidence that parasite species have been handed down almost unchanged, through a long line of host evolution. Species formation of *Mallophaga* has depended mainly on inheritance and isolation. In contrast to the usual conditions of insect biology, adaptation has played a subordinate part. Consequent exceptional interest of this group of parasites.

The President having expressed the general appreciation of Prof. KELLOGG's paper, the meeting proceeded to discuss

GENERAL BUSINESS.

The President, in calling upon the chairman of the Executive Committee to read his report, said they had several matters to decide, and it would be most expedient if the various points brought forward in the report were discussed separately.

K. JORDAN then read the following Report of the Executive Committee :

Mr. President, the Executive Committee has the honour of laying before this General Meeting four propositions, and asking its decision thereon, concerning :

(1) The organisation of an Entomological Committee on Nomenclature ;

(2) A Resolution of the Section on Economic and Pathologic Entomology ;

(3) The election of some additional members of the Permanent International Committee of Entomologists ;

(4) The election of Honorary Members of the Entomological Congress—and

¹ *Amer. Natural.*, 1913, p. 129.

(5) The choice of the place of meeting and the election of the President of the third International Congress of Entomology.

(1) ENTOMOLOGICAL COMMITTEE ON NOMENCLATURE.

The First International Congress of Entomology at Brussels charged the Executive Committee with the organisation of an Entomological Committee on Nomenclature, and we lay before you to-day a list of entomologists who are willing to serve on that Committee. Before submitting this list to the General Meeting for consideration, it is our duty to refer to an amendment proposed by Dr. L. O. HOWARD on Tuesday in the Section on Nomenclature, and carried at that meeting. The amendment is to the effect that the Resolution brought before the Congress by the Entomological Society of London, and discussed at the meeting on Monday, be referred to the Executive Committee for consideration, a report to be laid before this General Meeting. The Executive Committee agrees with the various propositions contained in the Resolution of the Entomological Society of London apart from a point of procedure, but considers it expedient to submit to you a separate Resolution for each proposition, instead of embodying the various propositions in one single Resolution. We have to deal with :

(a) The organisation of National Committees on Entomological Nomenclature in the various countries ;

(b) The election of an International Entomological Committee on Nomenclature ; and

(c) The adequate representation of Entomology on the International Commission on Zoological Nomenclature.

The Executive Committee is of opinion that, in order to render the scheme proposed workable, the members of the International Committee must be elected by the Entomological Congresses, while the National Committees should be appointed by the Entomological Societies of the respective countries. This we think will meet the views expressed in the Resolution of the Entomological Society of London.

(1) The Executive Committee proposes for election as members of the International Entomological Committee on Nomenclature the following Entomologists :

Le Comité Exécutif propose d'élire les Entomologistes suivants pour former le Comité International Entomologique de Nomenclature :

Das Exekutivkomitee schlägt die folgenden Entomologen zur Wahl als Mitglieder des Internationalen Entomologischen Nomenklaturkomitees vor :

N. Banks, East Falls Church.
 C. G. Gahan, London.
 K. Kertész, Budapest.
 F. Ris, Rheinau.
 S. Schenkling, Berlin.
 H. Schouteden, Brussels.
 Y. Sjöstedt, Stockholm.
 K. Jordan, Tring (as Secretary).

[The proposition is carried unanimously.]

The Executive Committee considers this small central committee sufficient for the present to carry out the wishes of the Congresses, considering the great help which presumably will be rendered by the National Committees ; but asks this Congress—

(2) To empower the International Entomological Committee on Nomenclature to elect, in conjunction with the Executive Committee and the National Committees, additional members as necessity arises, such election to be subject to the approval of the Congress following, but the additional members meanwhile having full voting power.

[Carried unanimously].

The next proposal refers to the formation of National Committees. The Executive Committee proposes—

(3) That the International Entomological Committee on Nomenclature be commissioned to enter into communication with the Entomological Societies of the world, with a view of forming National Committees on Entomological Nomenclature.

Le Comité Exécutif propose au Congrès—

De charger le Comité Entomologique International de Nomenclature de se mettre en rapport avec toutes les Sociétés Entomologiques afin de créer des Comités Nationaux de Nomenclature Entomologique.

Das Exekutivkomitee beantragt—

dass dieser Kongress dem Internationalen Entomologischen Nomenklaturkomitee den Auftrag erteilt, sich mit den Entomologischen Gesellschaften aller Länder zum Zwecke der Bildung von Nationalen Entomologischen Nomenklaturkomitees in Verbindung zu setzen.

[Carried *nem. con.*]

The next point on which the Executive Committee must ask the Congress to express an opinion refers to the general scope of work assigned to the above International and National Committees. The Executive Committee submits the following resolution to this General Meeting :

(4) This Congress commissions the International Entomological Committee on Nomenclature :

To collect, in co-operation with the National Committees, the opinions of entomologists on questions of nomenclature as affecting Entomology ;

To consider what elucidations, extensions, and emendations, if any, are required in the International Code ;

To confer with the International Commission on Zoological Nomenclature ; and to lay a

Report on these points before the next Congress of Entomology.

Le Congrès charge le Comité Entomologique International de Nomenclature :

De réunir, avec l'aide des Comités Nationaux, les opinions des entomologistes sur les questions de nomenclature concernant l'Entomologie ;

D'examiner s'il est nécessaire de faire des modifications, ajoutées, ou suppressions aux règles du Code International ;

De se mettre en rapport avec la Commission Internationale de Nomenclature Zoologique ; et

De soumettre un rapport sur ces questions au prochain Congrès d'Entomologie.

Dieser Kongress beauftragt das Internationale Entomologische Nomenklaturkomitee :

In Gemeinschaft mit den Nationalkomitees die Ansichten der Entomologen über Nomenklaturfragen, soweit sie die Entomologie betreffen, einzuholen ;

Darüber zu beraten, ob und welche Zusätze und Verbesserungen in den Internationalen Nomenklaturregeln notwendig sind;

Mit der Internationalen Zoologischen Nomenklaturkommission in Verbindung zu treten; und

Dem nächsten Entomologenkongresse einen Bericht über diese Punkte vorzulegen.

[Carried *nem. con.*]

The last proposition referring to nomenclature which the Executive Committee has to submit will, we trust, likewise meet with the approval of this General Meeting.

The Executive Committee proposes—

That this Congress commissions the International Entomological Committee on Nomenclature to communicate these resolutions, unanimously carried, to the Secretary of the International Commission on Zoological Nomenclature and to take such action as to ensure the adequate representation of Entomology on the International Commission on Zoological Nomenclature.

Le Comité Exécutif propose—

Que le Congrès charge le Comité Entomologique International de Nomenclature de communiquer ses décisions unanimes au secrétaire de la Commission Internationale de Nomenclature Zoologique et de prendre les mesures nécessaires afin que l'entomologie ait le nombre de représentants correspondant à son importance dans la Commission Internationale de Nomenclature Zoologique.

Das Exekutivkomitee beantragt—

Dass das Internationale Entomologische Nomenklaturkomitee diese einstimmig gefassten Beschlüsse dem Sekretär der Internationalen Zoologischen Nomenklaturkommission mitteilt und Schritte tut, dass die Entomologie ihrer Bedeutung entsprechend in der Internationalen Zoologischen Nomenklaturkommission vertreten ist.

[Carried *nem. con.*]

As this was the last resolution referring to nomenclature, the President asked if any Member wished to make further remarks on the subject.

L. O. HOWARD rose to a question of privilege. He said he

feared that his motion made on Monday, to refer to the Executive Committee the report of the Entomological Society, had been taken amiss by the members of the London Society, and as indicating some opposition to the action of that body. He assured the Congress that he had the highest respect for the Society, and thoroughly commended its action. His motion on Monday he considered simply a matter of proper Parliamentary procedure.

F. D. MORICE, as President of the Entomological Society of London, and for other members of the Society present at the Congress, wished to assure Dr. HOWARD that they had not regarded his amendment as at all antagonistic to their own motion, but rather (as he believed) an improvement on it.

G. T. BETHUNE-BAKER expressed the view that the Resolutions of the Congress entirely met the motion of the Entomological Society of London. He expressed his satisfaction and gratitude for the way in which the Executive Committee had acceded to their desire. He also thanked Dr. HOWARD for his words in explanation of his amendment, and the President of the London Society for withdrawing the criticism he had made in another place.

H. SKINNER said he had seconded Dr. HOWARD's Resolution, as he thought it would avoid misunderstanding. The unanimous action on the Resolutions *in re* nomenclature showed the wisdom of this action.

G. WHEELER said that Mr. BETHUNE-BAKER had expressed already what he would have wished to say. The point which seemed to him most important, viz. that the National Committees should be appointed by the entomologists of the different countries, had been carried unanimously, and speaking for himself he was absolutely satisfied, and was sure that the Entomological Society of London would be also.

C. GORDON HEWITT asked what would be the action of the International Entomological Committee of Nomenclature in the case of a disagreement with a finding of the International Commission of Zoological Nomenclature.

K. JORDAN, in answer, said that the Committee would try to carry the point if the matter was of importance for Entomology. However, only those findings were brought before the Zoological Congresses on which the vote of the Commission was unanimous.

The President then called for the continuation of the Report of the Executive Committee, and K. JORDAN resumed :

The Section on Economic and Pathologic Entomology appointed on Wednesday a Committee for the purpose of considering and drawing up a Resolution on the formation of an International Commission on Insect Pests. The Resolution was proposed in Committee by Dr. GORDON HEWITT, seconded by Sir DANIEL MORRIS, and carried unanimously. It was submitted to the adjourned meeting of the Section on Thursday morning, and on the motion of Dr. L. O. HOWARD, seconded by Mr. F. A. LOWE, passed unanimously. The Resolution is as follows :

That this Congress, after a discussion of the various problems incident to the prevention of the spread of insect pests from one country to another, cordially supports the proposed formation by the International Institute of Agriculture of an International Commission to deal with these problems, in the firm belief that international action is the best means by which the greatest amount of protection can be secured with the least injury to international trade in natural products : that a copy of this Resolution be forwarded to the President of the International Institute of Agriculture in Rome.

[Passed unanimously by the General Meeting.]

The third subject of the Report concerns the election of some additional members of the Permanent International Committee of Entomologists. The Executive Committee recommends for election the following entomologists :

H. A. Ballou, Trinidad.
 N. Banks, East Falls Church.
 M. Bernhauer, Grünberg.
 P. L. Boppe, St. Dié.
 A. Dampf, Königsberg.
 S. A. Forbes, Urbana.
 F. Hendel, Wien.
 W. Lundbeck, Copenhagen.
 E. Petersen, Silkeborg.

C. S. Ramsden, Guantanamo (Cuba).
 H. Rebel, Vienna.
 A. Schwarz, Washington.
 F. A. Spaeth, Vienna.
 Mehmed Sureya, Constantinople.
 J. F. Tristán, San José (Costa Rica).
 F. W. Urich, Trinidad.
 E. M. Walker, Toronto.

[Carried *nem. con.*]

The fourth item on which the Executive Committee has to report refers to the election of Honorary Members of the Entomological Congresses. The Honorary Members receive the publications of the Congress free of charge. But we understand from the Treasurer that he is not adverse to donations addressed to him by members, honorary or ordinary, or other friends of Entomology. Four of the Honorary Members elected by the First Entomological Congress have died: MEINERT, PLATEAU, SCUDDER, and SNELLEN. The Executive Committee recommends for election :

G. B. Cresson, Philadelphia ;
 E. Frey-Gessner, Geneva ;
 and P. R. Uhler, Baltimore.

[Elected unanimously.]

There is now before us the very important question of the place of meeting of the Third Entomological Congress. The Executive Committee has received invitations from the United States of North America, Frankfort a/M., and Vienna, and has had a conference with the members of the Congress representing North America, as well as with Dr. NASSAUER of Frankfort and CUSTOS A. HANDLIRSCH of Vienna. Dr. MALCOLM BURR, secretary of the Executive Committee, will read to the meeting two letters of invitation addressed to the Executive Committee by the American Entomological Society, the Entomological Society of America and the American Association of Economic

Entomologists, and presented by Professors CALVERT, FORBES, and OSBORN, and cordially endorsed by Prof. KELLOGG, for the Pacific Coast Entomological Society, and Dr. GORDON HEWITT, for the Entomological Society of Ontario. The invitations are couched in such kind terms, and the prospect of the Third Congress of Entomology being held in the United States is so alluring, that the Executive Committee has had some serious difficulty in coming to a decision as to which place it should recommend to-day for the meeting of the next Congress. After consultation with the American colleagues and various other members of the Congress the Executive Committee has arrived at the opinion that this young association should meet at least once more in Europe before going to the United States. It is now for this meeting to decide which country and town in Europe would be the most suitable for the Third Congress. As the first two Congresses were held in Western Europe, it appears advisable to meet for the third time in a country of Central Europe, and for various reasons Vienna recommends itself as a most suitable place. The Executive Committee therefore proposes Vienna as the place of meeting of the Third International Congress of Entomology, to be held in 1915, with CUSTOS ANTON HANDLIRSCH as President. [Carried by acclamation.]

A. HANDLIRSCH dankt dem Kongresse im Namen der oesterreichischen Entomologen für das grosse Vertrauen, welches ihnen durch die Wahl Wiens als Ort für den nächsten Kongress bewiesen ist.

The President then gave his farewell address, as follows :

Ladies and Gentlemen: Our principal and most pleasant duty, on this last formal meeting of the second International Entomological Congress, is to thank those who have so kindly helped us to make the meeting a success.

We have to thank the Delegates of the Oxford University Museum for the use of this lecture-room and the central court of the Museum; among the Heads of the Museum Departments—Prof. BOWMAN for the use of the writing-room, Prof. BOURNE for rooms in his Department, Prof. SOLLAS for his lecture-room, and Prof. Sir W. OSLER for the Secretary's room.

We also desire to thank the two assistants in the Hope Department, Mr. A. H. HAMM and Mr. J. COLLINS, for helping the members of the Congress to study the collections, and to express our gratitude to many workers in the Department who have also given the kindest assistance—Mr. R. S. BAGNALL, Dr. DIXEY, Mr. ELTRINGHAM, Dr. LONGSTAFF, the Rev. K. ST. AUBYN ROGERS, and Commander WALKER.

That the Congress has passed so successful a week, in spite of the unfortunate weather, is mainly due to two circumstances. The first we owe to the Delegates of the University Museum, namely the fact that all our formal meetings, and the Hope Collections, which have provided interest between the meetings, have been under a single roof. The second fortunate circumstance we owe to the generosity of the Warden of Wadham College—the proximity of the tent in which we have been able to take our meals, and the beautiful garden where we have walked and rested, when the weather permitted, in the intervals between our meetings.

We desire cordially to thank the Warden and Fellows of New College for the use of the College Hall for the opening meeting, the Warden and Fellows of Wadham College for lending the Hall for our banquet, the Warden and Fellows of Merton College; New College, and Wadham College for allowing members to reside in College rooms, and for all the exceedingly efficient arrangements which have been made. With these thanks we desire especially to associate the names of Mr. E. S. GOODRICH, F.R.S., Mr. GEOFFREY SMITH, and Dr. F. A. DIXEY, F.R.S., for acting as hosts in their respective Colleges. I must especially speak of the kindness of Dr. DIXEY in undertaking, at very short notice, to arrange for the banquet at Wadham, and also for all the details, which have been so necessary for our comfort, that have been planned by him in the Warden's garden and in the College.

In speaking of the Colleges we also wish to thank the Principal and Fellows of Jesus College, the Provost and Fellows of Queen's College, and the Rector and Fellows of Lincoln College, who had kindly given the necessary permission for rooms to be occupied if the number of the members had made it necessary; and here I may say that I am sure that had it been needful other Colleges would have been equally ready with their kind permission.

The success of the meeting has also been greatly assisted by those Oxford residents who have offered hospitality to our visitors, and we desire to give our special thanks to Prof. and Mrs. BOURNE, Prof. and Mrs. PERCY GARDINER, Dr. and Mrs. HOEY, Mr. and Miss NAGEL, and Mr. and Mrs. ARTHUR SIDGWICK. I wish also to thank Mrs. DIXEY and my wife and my daughter for all they have done in helping to entertain members of the Congress.

The two excursions on Wednesday formed an important feature of the meeting, and our thanks are specially due to those who have so kindly received us, as well as to others who have expressed the wish to offer hospitality to the Congress, and would have done so had our numbers been larger. We heartily thank the President and Fellows of St. John's College for entertaining the party in Bagley Wood, and also the Rt. Hon. L. V. HARCOURT, M.P., for his spontaneous suggestion that a party should visit Nuneham. We also warmly thank Sir ARTHUR EVANS, F.R.S., who invited us to Youlbury, and Mr. VERNON and Lady MARGARET WATNEY, who invited us to Cornbury Park, and we express our regret that the numbers of the Congress were not sufficient for us to accept this kind hospitality, as we should have greatly wished to do. I also desire to thank in advance the Hon. WALTER ROTHSCHILD, F.R.S., for the excursion to the Tring Zoological Museum which will take place to-morrow—a fitting and delightful end, to which we are all looking forward with so much pleasure and interest.

For the preliminary preparations, which had to be made long before the opening of the Congress, we have to thank the very efficient local committee with Dr. DIXEY as chairman. At a time when he was especially busy in preparations for the visit to Oxford of Delegates for the 250th Anniversary of the Royal Society, at such a time of stress, and with his many other insistent duties, Dr. DIXEY arranged for all the meetings of this committee, and hospitably entertained its members in Wadham College. We have to thank the secretaries, Mr. H. ELTRINGHAM and Mr. G. H. GROSVENOR and the other members, all of whom rendered most efficient help. Among them I may especially mention Dr. G. B. LONGSTAFF and Prof. SELWYN IMAGE, who came to Oxford on purpose for the meetings, and Commander

WALKER, who edited the guide-book. I may here also express our indebtedness to Prof. SELWYN IMAGE for his very kind help in designing the badge.

We also received the kindest assistance from Mr. WALTER ROTHSCHILD and Dr. KARL JORDAN, who visited Oxford on purpose to give help and advice.

I spoke, at our opening meeting, of the sad cause of Dr. MALCOLM BURR's absence, and we all rejoice with him that Mrs. BURR's health is now so far restored that he has been able to spend the last days of the Congress with us in Oxford. His enforced absence led to much difficulty, and might have led to disaster. On Thursday of last week at this time the manuscript copy of our Programme had not been written, and I really do not know the hour of night or early morning at which Mr. ELTRINGHAM took it to the printers. When we remember that Saturday is only a half-day, it will be realised what this meant; but owing to the way in which Mr. ELTRINGHAM threw himself into the breach, and also to the very efficient help that Mr. GROSVENOR was able to afford him during part of the time, all our difficulties have been overcome. I must here also speak of the great kindness of Mr. H. ROWLAND-BROWN, who, when he heard of our difficulties last week, telegraphed to us, offering to come to Oxford and help.

At this, the last of our most successful meetings, I am sure you would wish to thank all Presidents, Vice-Presidents, and Secretaries of Sections, all readers of papers, and those who have contributed to the discussions. And, for myself, allow me warmly to thank every one of you for the great kindness and consideration shown to me throughout the meeting.

We now adjourn—all of us, I am sure, looking forward to our next meeting in Vienna, under the presidency of my distinguished successor CUSTOS A. HANDLIRSCH.

THE BANQUET.

HELD IN THE HALL OF WADHAM COLLEGE, FRIDAY, AUGUST 9TH.

Early in the week it was found impracticable to hold the banquet in the Hall of Christ Church, as had been intended, but thanks to the efforts of Dr. F. A. DIXEY it was arranged, by kind permission of the Warden and Fellows of Wadham, to hold the dinner at that College.

A very large number of the members of the Congress sat down to an excellent repast served in the fine old Hall.

Following the usual loyal toast, the President said he now had the honour of proposing the toast of the science that they were celebrating at the Oxford Congress, and that they would continue to celebrate in future Congresses—"Success to Entomology." A friend who was in a high position in the British Colonial Office once told him that, whenever he heard of an appointment to be made in the Colonial service, where a young man was wanted for a position of responsibility in a trying climate, he always inquired whether there was a naturalist available for the post. He knew well that in an enthusiastic naturalist he would also secure a better public servant (applause). The contemplation of such beneficial results arising spontaneously from the gratification of certain intellectual interests, led us to inquire why it was that we studied natural history, entomology, or any other science. If they analysed the reasons, he thought they would agree with him that the primary, in fact the only real motive, was that of finding out; they worked because they were interested, and any further object, however laudable in itself, only tended to bias and mar the inquiry. He remembered hearing Sir MICHAEL FOSTER say that it was by curiosity that our first parents lost the Garden of Eden, but that by transmitting to us that same curiosity, they had given us a golden bridge, by which we were able to re-enter Paradise (laughter). There was a correspondence on this very subject between DARWIN and his old Cambridge teacher HENSLOW,

who had maintained that science pursued without a practical end was merely building castles in the air.

DARWIN's reply seemed to him unanswerable:

"I rather demur to one sentence of yours," he said—"viz. 'However delightful any scientific pursuit may be, yet, if it should be wholly unapplied, it is of no more use than building castles in the air.' Would not your hearers infer from this that the practical use of each scientific discovery ought to be immediate and obvious to make it worthy of admiration? What a beautiful instance chloroform is of a discovery made from purely scientific researches, afterwards coming almost by chance into practical use! For myself I would, however, take higher ground, for I believe there exists, and I feel within me, an instinct for truth, or knowledge or discovery, of something of the same nature as the instinct of virtue, and that our having such an instinct is reason enough for scientific researches without any practical results ever ensuing from them."¹

DARWIN here gave the real motive for research, and they would notice that when the followers of the more fundamental sciences, Physics and Chemistry, began to think of practical commercial uses, the science of their investigations dropped to another and a lower level. He expected that they had heard of the terms which had been suggested for the different degrees in the attainment of inaccuracy—how there were liars, liars with an uncomplimentary adjective, and "expert witnesses" (laughter). If that were true—even in the least degree true—it meant of course that the scientific spirit was incompatible with the qualities required in an expert witness. He dwelt on these facts because he thought that Entomology stood out as the one science in which a practical application was, in his experience, without an injurious effect upon investigation. In Entomology, scientific inquiries of all kinds were going on for the purpose of helping mankind, but in spite of the application their researches could still be conducted on purely scientific lines; and he did not know of any other science for which this could be said so truly as it could for Entomology. If this opinion were sound, it followed that our science occupied a high position in the scale of human

¹ *More Letters of Charles Darwin*, London, 1903, vol. i., p. 61. Letter dated April 1st, 1848.

knowledge. Economic Entomology was a vast field in which practical applications were sought, and sought most successfully, and yet if any one wished for examples of work carried out in the true spirit of science, he could not do better than visit Dr. L. O. HOWARD at Washington, Prof. W. M. WHEELER at Harvard, Dr. R. C. L. PERKINS in Honolulu, or the rooms in our National Museum from which Mr. GUY A. K. MARSHALL inspires and directs the investigations of many a naturalist in Africa.

For this special reason, as well as for its many other unrivalled charms, he invited them to drink the toast of "Success to the Science of Entomology."

He would close in the words of CHARLES DARWIN, who, in a letter to Sir JOHN LUBBOCK, wrote:

"I feel like an old war-horse at the sound of the trumpet, when I read about the capturing of rare beetles—is not this a magnanimous simile for a decayed entomologist?—It really almost makes me long to begin collecting again. Adios.

"'Floreat Entomologia!'—to which toast at Cambridge I have drunk many a glass of wine. So again, 'Floreat Entomologia.' N.B.—I have *not* now been drinking any glasses full of wine."¹

The Chairman then gave the toast in CHARLES DARWIN'S words, "Floreat Entomologia."

Dr. EVERTS (The Hague) next asked the company to drink in a hearty manner the toast of the health of the President of the Congress and the General Secretary. He thanked the two gentlemen he had named for all that they had done in arranging the Congress, which had proved extremely successful. He was sure they would all leave the venerable City of Oxford with sentiments of gratitude, and they never would forget the hospitality which had been extended to them, and which had made the week a memorable one (applause).

The company sang "For he's a jolly good fellow," and cheers were given for the President and Mrs. POULTON.

The President said they had really thanked him a great deal too much during the afternoon meeting, and he could only say

¹ *Life and Letters of Charles Darwin*, 1887, vol. ii., p. 141. Letter written before 1857.

again what he said then, that they had given him the happiest week he had ever spent, while in selecting him as President for the Congress they had allowed him to occupy the position he honoured most. There were others who had done far harder work in connection with the Congress than he had, and he would therefore ask Dr. DIXEY, Dr. MALCOLM BURR, and Mr. ELTRINGHAM to respond to the toast.

Dr. DIXEY said, on behalf of the Warden and Fellows of Wadham College, that they felt themselves highly honoured and extremely proud at having been allowed the privilege of entertaining that great Congress on that occasion. If there were any shortcomings that might be detected that evening, he would only ask them to be good enough to excuse them in view of the somewhat hasty arrangements that had to be made to hold the dinner there (applause). Might he just say one word more before leaving to a much more eloquent gentleman than himself the due acknowledgment of this toast? He thought it might be of interest to those present to note that on the walls hung the portraits of four of those who took the most prominent part in the foundation of the illustrious Royal Society—JOHN WILKINS, CHRISTOPHER WREN, THOMAS SPRAT, and SETH WARD, in regard to the last of whom it was said he was “never destitute of friends of the fair sex, never without proffers of wives” (laughter). Then when they came to the Warden’s private garden, in which they had spent, he hoped, many happy hours, it might be of interest to them to know that the tent for their accommodation was pitched just below the earthwork which was thrown up as part of the City defences during the Civil War. Just to the east of the tent they would notice a kind of terrace walk, which was really a rampart, or earthwork; and those of them who were interested might observe the ramp at each end exactly as it was left by CHARLES’S soldiers. At the very spot where they had been enjoying social conversation, CHARLES’S soldiers took refreshment while expecting the advance of the Parliamentary troops under FAIRFAX, who lay at Marston close by. As they all knew, the expected siege of the City never came off, for by the express desire of the King the City of Oxford was evacuated by his own soldiers, though it had a good prospect of holding out a

stubborn defence. The members of the Congress had also had to repel the advances of "hostile forces," but in their case the only guard that was necessary to ensure the privacy and the sanctity of their proceedings was a single policeman in plain clothes at the north-west corner of the garden (laughter). The "siege," if they were to trust the report made to them by their excellent garrison, had been a most arduous one, for many people were attracted by the sounds of revelry within and tried to effect a forcible entrance (laughter). "However," said Dr. DIXEY, "'All's well that ends well,' and I trust the arrangements made have met with the approval of this great and distinguished body" (applause).

Dr. MALCOLM BURR said that from the moment they parted company at Brussels, two years ago, he had been looking forward to the meeting in New College, at which he knew they would see their friends from nearly every country in Europe, Asia, and Africa, and a large and powerful invasion from America. It was a great disappointment to him that he was unable to assist in the welcome to the members of the Congress, and if he came to the Congress a little late, the pleasure of arriving was doubled by the warmth of the welcome which he had on all sides, from friends of all nationalities and speaking all languages. His own interest in Entomology was that of an amateur who had taken up the study of a relatively unimportant group of insects, but perhaps, with a natural contrariness of disposition, he had felt that the importance of this Congress must rest perhaps in the fact that—with all due deference to Prof. POULTON's remarks—it would bring home to the public that Entomology was, after all, a practical science and a practical subject for consideration, and if Entomology was to win the support of those people who were willing to supply that support, it must justify itself practically as well as from an academic point of view. For that reason there was an aspect of the Congress which could not be overrated; they must bring it home to the layman that Entomology was a practical, everyday matter, which entered deeply and closely into nearly every profession and business. He could give this opinion more candidly, because his own amusements were absolutely academic. The feeling of disappointment which he had at being unable to attend the opening ceremonies of the Congress, was doubled

by the knowledge that he was obliged to throw the responsibility of a great deal of work on to others, and he could not express too deeply his gratitude to those friends who had so gallantly undertaken the hard work of organisation, in regard to which he was sure they would get all the blame for anything that might go wrong, while he would enjoy the glory (applause).

Mr. H. ELTRINGHAM said he was quite overwhelmed with the delightful way in which those present had expressed their approval of anything he had been able to do towards the success of this Congress. He would like to remind them that it was quite impossible for any one person to be responsible for every detail of a great meeting such as that which they had had in Oxford that week. He had had the greatest assistance from a large number of friends. Quite unexpectedly he had to take a very much more prominent part in this Congress than he had anticipated, and no one regretted more than he did the very unfortunate circumstances which prevented his good friend Dr. BURR from being present with them the whole of the week. Quite apart from his attractive personality, they had sadly missed those wonderful linguistic capabilities for which he was so famous. He would like to tender his thanks to Mr. LOESCH, Dr. BURR's assistant, who had helped in a great variety of ways; to his friend and colleague, Mr. GROSVENOR, who had worked quite as hard as he (Mr. ELTRINGHAM) had, both before and during the Congress; and as to Dr. JORDAN, he thought he could best express what he felt towards him by saying he had been nothing less than his guardian angel (laughter and applause). He thanked them very heartily indeed for their kindness to him during a long and busy week, and though he had had a great deal to do, it had not detracted from the great pleasure it had been to him to renew many old acquaintances, and make many new ones, which he was quite confident would prove equally lasting and delightful (applause).

Dr. G. B. LONGSTAFF, in proposing the toast of "The Ladies," said he thought this was a matter which required that gallantry that was associated with persons of more tender age than himself (laughter). There must be some reason for having chosen an old fellow like him to propose the toast, and he conjectured it was

that the powers that be thought that a long experience of life would teach a man more and more how much he owed to the fair sex (laughter). He could only suppose that Mr. ELTRINGHAM and Mr. GROSVENOR had been much too busy to realise by what delightful creatures they were surrounded, or otherwise he did not think Mr. ELTRINGHAM would have presumed to call Dr. JORDAN an angel (laughter). He did not want to lower Dr. JORDAN one least bit in the esteem of any one present, but to claim that he should be raised to the rank of an angel could not but be an insult to those who, in this country at all events, were in the majority (laughter). He gave them the toast of "Les Dames."

The President said he was sure they would all receive with great enthusiasm the information that Miss ROWLAND-BROWN had consented to reply for the ladies.

Miss ROWLAND-BROWN said she wished this was as thoroughly deserved as it was a great honour, but it was said, in her case, that honours fell sometimes to the most undeserving. She was glad, however, to have the opportunity of expressing, on behalf of her sisters of all nations, and on her own behalf, their gratitude for the kindness, cordiality, and hospitality with which they had been received in the beautiful City of Oxford. In his excellent speech Dr. LONGSTAFF had surely exhausted all the delightful things it was possible to say about the ladies. It had been a great delight to them all to be here amidst the dreaming spires of her whom so many fondly called Alma Mater. Oxford was a woman, and Science, in all languages, was a woman. So far, in this great science, few women had yet distinguished themselves, but where those present led, others might surely follow, for science, that woman of all countries, was a creed.

Continuing, Miss ROWLAND-BROWN addressed the company in French and German, and finally she said she could only end by repeating the thanks of the ladies present for what they would look back upon as one of the most delightful weeks they had ever had. They could not do better than take leave of each other in that most beautiful and expressive word which all nations had adopted—*adieu* (applause).

The President said that although it transcended the bounds of custom he was sure they would wish him to express in their

name their thanks to Miss ROWLAND-BROWN for her charming speech.

The President-Elect, CUSTOS ANTON HANDLIRSCH (Vienna), speaking in German, said that as President of the next Congress he thanked them first of all very heartily for having chosen the banks of the Danube for the next gathering. He could only assure them that they all appreciated the decision, and they would endeavour to do their best to give the members of that Congress a hearty welcome. He would get in touch with all the Institutions in Vienna and the Government, and he was sure they would find Vienna a most charming and delightful city. At the same time he must thank the President, his assistants, and the City of Oxford for the warm welcome that had been extended to the members of the Congress on all sides. They were interested in all they had seen, and had learned a great deal.

Meine Damen und Herren! Wenn ein Oesterreicher auf Reisen geht, so pflegt er seinen Freunden etwas "Besonderes" mit nach Hause zu bringen. Dieser alten Gewohnheit gemäss habe ich die Strassen Londons durchstreift, um charakteristische Gegenstände zu erstehen. Bei der Fülle des Gebotenen war aber die Wahl schwer und das Endresultat—ein grosser *kit-bag*. In diesem nehme ich nun das wertvollste aller Geschenke mit nach Hause—den nächsten Entomologen-Kongress! Wie gross wird die Freude meiner Freunde und Kollegen sein, wenn ich auspacke! Leider ist aber mein *kit-bag* nicht gross genug, um auch einige der ebenso ehrwürdigen als gemütlichen und reizvollen *colleges* Oxfords aufzunehmen, um sie seinerzeit in Wien den Teilnehmern des 3. Kongresses zur Verfügung stellen zu können. Solch schöne Institutionen kennen wir in Wien leider nicht; sie sind eine englische Spezialität, und wir werden uns daher sehr bemühen müssen, wenn wir es im Jahre 1915 unsern lieben Gästen in Hotels und Familien nur annähernd so gemütlich machen wollen. Sollte sich jedoch der Wiener Kongress, was ja nicht unmöglich erscheint, zu ganz besonders hohen Zahlen emporschwingen, sodass die Hotels nicht ausreichen, so bleibt uns ja immer noch ein Ausweg, den uns die praktischen Kollegen Oxfords schon angedeutet haben—die Errichtung von Zelten in den schönen Gärten Wiens. In der sichern Erwartung, dass

sich dies als notwendig erweisen wird, rufe ich Ihnen ein herzliches "Auf fröhliches Wiedersehen in Wien" zu.

The President then called upon any of the members present to speak if he felt disposed to address the company.

Dr. G. HORVÁTH (Budapest), speaking in French, in happy terms proposed the health of Mrs. and Miss POULTON, whose gracious hospitality so many members of the Congress had enjoyed.

Prof. A. LAMEERE (Brussels), speaking in French, said they had passed together in Oxford some of the happiest days, and he knew they would never be forgotten by any of them. They all knew what a huge success the Congress had been, and he could not thank the President and his assistants enough for all that they had done. They had heard numerous interesting and exciting lectures both on economic and practical subjects, and the number attending the lectures had again shown their great popularity. With regard to the accommodation found in the colleges, hotels, and everywhere, he could but add that they had been most hospitably treated, and really he could not adequately express how gratified they felt. He drank to the health of the President and the others present, and to the future Congresses.

Dr. L. O. HOWARD (U.S.A.) said he found himself in the position of the man who was fishing on one occasion on the banks of the Thames, and, his foot slipping, fell in. The man who pulled him out said, "How did you come to fall in?" and the man said, "I did not come to fall in; I came to fish" (laughter). Nevertheless he was glad to have the opportunity of telling them, on behalf of the American contingent, how much they had enjoyed meeting their friends there, how much they had enjoyed the hospitality which had been extended to them, how much they had enjoyed the old City of Oxford, and the privilege of living in their colleges, and being in an atmosphere of the Middle Ages, which was entirely non-existent in the United States. They were too new in the States altogether—they realised that fact—and when they came to Oxford they fairly revelled in the old things. In the Congress of Entomology they were not English, they were not Germans, French, Belgians, Austrians—they were of the nation of Entomologists, a world-nation, and

there was in no science that existed a feeling of such perfect friendship, of such perfect companionship, as there was in the Science of Entomology (applause).

Prof. KOLBE (Berlin), speaking in German, associated himself heartily with the words of Prof. LAMEERE, and said :

Als die Einladung zu dem 2. Internationalen Entomologen-Kongress an uns erging, nahmen wir mit Freuden diese Einladung an und bereiteten uns erwartungsvoll auf die Reise nach England und speziell Oxford vor. Diese althistorische und besonders durch ihre berühmte, aus dem frühen Mittelalter stammende Universität ausgezeichnete Stadt mit den zahlreichen, von Wiesen und Wald in grüner und blühender Fülle umgebenen altertümlichen Gebäuden der *colleges* ist ja eine ganz eigenartige Attraction. Dazu kommt das den Entomologen besonders anziehende *Hope Museum* mit dem zahlreichen typischen Material von HOPE, WESTWOOD, und anderen Entomologen älterer und neuerer Zeit. Die entomologischen Sammlungen des Museums wurden dementsprechend während der Tage des Kongresses von zahlreichen Mitgliedern fleissig besucht und das Material von vielen Herren eingehend studiert.

Die Sitzungen des Kongresses waren ernster und vielfach austrengender Arbeit gewidmet, und wir sehen mit Freuden, dass viele und vielseitige Themata aus fast allen Gebieten der Entomologie vorgetragen, in Discussionen behandelt und eingehend gewürdigt worden sind. Die behandelten Themata bieten eine reiche und belehrende Fülle von Anregungen für viele der hier anwesenden und für viele nicht hierher gekommene Entomologen aller Länder. Wir finden, dass die Entomologie durch die Kongresse in Breite und Tiefe konsolidiert wird.

Sodann drängt es mich, von ganzem Herzen zu danken für die anerkannteswerte gastliche Aufnahme in Oxford, die uns durch die lobenswerte Vermittelung des Herrn Professor POULTON zu teil geworden ist. Ich speziell bin mit meiner Frau von herzlichem Danke beseelt für die liebenswürdige gastliche Aufnahme während der ganzen Zeit des Kongresses in Hause des Herrn und der Frau Professor A. SIDGWICK.

Ein besonderer Dank gebührt aber den Organisatoren und Veranstalter des Kongresses ; denn es ist keine leichte Arbeit, einen solchen Kongress in jeder Hinsicht zufriedenstellend und

fruchtbringend zu gestalten. Darum zollen wir unsern Dank in erster Linie unserem hochverehrten Präsidenten Herrn Professor E. B. POULTON, dann dem General-Secretair des Kongresses Herrn Dr. MALCOLM BURR und seinen Assistenten, namentlich Herrn H. ELTRINGHAM, und schliesslich all den Damen und Herren, die es sich zur Aufgabe gestellt hatten, uns Fremden Führer und Helfer zu sein. Ich habe die Ehre, diesen tiefgefühlten Dank auszusprechen im Namen aller aus *Deutschland*, aus der *Schweiz* und aus *Luxemburg* hierhergekommenen Mitglieder und ihrer Damen, und ich bin erfreut, diesen Dank hier an dieser Stelle öffentlich verkündigen zu dürfen, mit der Versicherung, die Erinnerungen an Oxford, an den Entomologen-Kongress hierselbst und an unsere Kongressfreunde stets und immerdar im Gedächtnis aufzubewahren.

Dr. E. OLIVIER (Moulins) spoke in similar terms in French, associating himself warmly with the words of the preceding speakers. He said :

Monsieur le Président, Mesdames et Messieurs: Je viens exprimer les regrets de plusieurs de mes compatriotes qui ont du renoncer à effectuer le voyage d'Angleterre pour prendre part aux travaux du Congrès. Les motifs de leur absence sont, pour quelques uns, le mauvais état de leur santé, et, pour plusieurs autres, des réunions de famille qui les retiennent chez eux à l'occasion des vacances. Tous ont éprouvé la plus vive contrariété d'être privés du grand plaisir d'assister à cette splendide réunion qui leur offrait l'occasion d'établir ou de resserrer de précieuses relations de confraternité avec les entomologistes des Deux-mondes.

Car l'étude des insectes, de leurs mœurs, de leur classification est toujours très en honneur chez nous, et les naturalistes qui s'y occupent de cette branche si importante de la zoologie sont de jour en jour plus nombreux.

Aussi la patrie de RÉAUMUR, de GEOFFROY, d'OLIVIER, de LATREILLE, et de tant d'autres illustres savants applaudit sans réserve à cette institution des Congrès internationaux qui marque une étape importante dans l'histoire de l'Entomologie et produira pour la science les plus féconds résultats.

C'est avec une extrême satisfaction que tous nos collègues d'Outre-manche apprendront la réussite si complète du Congrès

d'Oxford ainsi que la grandiose et sympathique réception qui leur était offerte par les entomologistes anglais.

Personnellement, c'est de tout cœur que j'adresse aux membres du Comité l'expression de ma reconnaissance et, au nom des entomologistes français, je lève mon verre à l'heureuse création du Congrès, à son fonctionnement désormais assuré, et je souhaite à la prochaine réunion de Vienne le brillant succès de celles qui l'ont précédée.

F. WICHGRAF (Berlin), speaking in English, said that as an amateur entomologist he was glad to have an opportunity to express his thanks for the great kindness he and others from Germany had experienced at the hands of their English hosts and friends (applause). As far as he could see, there was nothing which ought to separate the two nations, except perhaps the English Channel (laughter), and he was sure those who had passed such happy days during the past week in this beautiful City would, when they got back to Germany, do what they could to dispel the distrust of their countrymen, and establish a permanent understanding of friendship between the two great and closely related nations (applause). He drank to the health of the generous country of Great Britain, and asked his friends to join him in three hearty cheers for Old England (applause).

Señor BOFILL (Barcelona), speaking in Spanish, thanked his English friends for their hearty and cordial reception. He and his compatriots would never forget that it was to England that Spain owed her beautiful and gracious Queen. He said :

Señores y Señoras : Al levantarme para unir mi voz al concierto que en todos los idiomas estamos dando en pro de la Ciencia, brindo ante todo por Ynglaterra, esta gran Nacion, á la que ademas de la amable hospitalidad de que nos esta haciendo objeto, debemos nuestra Reyna, que por su hermosura y por sus dotes de bondad y discrecion es nuestro encanto. Brindo tambien por la prosperidad de todas las Naciones aqui representadas y finalmente brindo para que podamos todos los aqui presentes reunirnos en el próximo Congreso de Viena.

Prof. SJÖSTEDT (Stockholm), returning thanks in the name of the Swedish Government and the Stockholm Academy of Science, said :

Ladies and Gentlemen : When I left Stockholm a few weeks

ago, the town was beautifully decorated with the flags of all nations ; flags of most of the European countries, of North America, South America, Asia, Africa, and Australia. It was the Olympic Games that had collected athletes from all the corners of the world to compete for the different prizes.

This Congress also is a sort of Olympia, with representatives from places wide apart, who have assembled not for corporeal competitions, but to gain scientific victories. It seems to me that the expression used by our Crown Prince when inaugurating the Olympiad may also be applied to this Congress with its many different paths of exploration and their representatives, namely, that "the best fitted shall win." This expression applied to the present conditions would mean that the outcome of all our discussions, and the ideas propounded which solve the different problems best, will be a victory gained by science.

In the name of the Swedish Government and the Royal Swedish Academy of Sciences, which I have the honour to represent, I beg to tender my best wishes to the Congress, at the same time expressing my admiration for the manner in which Prof. POULTON as President has conducted the proceedings of this Congress.

Herr JUNK (Berlin) said, perhaps those present knew the story of the German medical student who was entering for his first examination, which they in Germany called the "Physikum." The Professor asked him, "How many legs has the insect?" and thereupon the student promptly answered, "An insect has two legs, sometimes three legs, maybe four legs, in very rare cases it has five legs, but never six" (laughter). "Where on earth have you studied insects?" asked the Professor, and the student answered, "In your collection" (laughter). Well, the collections which he had seen in the University Museum at Oxford, he must confess, were not like that German Professor's collection. The insects had all six legs, except, perhaps, some monstrosities. But not only were the collections so magnificent and beautiful, but everything else which was to be seen was so exceedingly interesting, that really he felt as though he wanted to be an insect himself, so that he might have six legs with which to get about. But quite apart from the scientific treasures which they had been shown, the social gatherings, and especially that on Wednes-

day afternoon, had proved of the greatest pleasure to all. He did not remember ever having seen anything so charming as they had had the privilege of seeing at Nuneham. He never would forget that very pleasant afternoon, when the real British hospitality, of which they had heard before, was extended to them. Perhaps it was a little dangerous that Englishmen should show Germans that England was such a beautiful country (laughter). But he was sure the danger was not so great, and that there never would be anything like war or such things, about which the German journals and the English journals so often wrote (applause). He thought it was quite impossible. He hoped the President would send the heartiest thanks of the Congress to Mr. HARCOURT for the splendid way in which they were received at Nuneham (applause).

The Rev. F. D. MORICE said he combined the distinction that evening of being a delegate from the Entomological Society of London and from the University of Oxford, and although he had not been directed by either of those two bodies to do anything in particular, he might perhaps be excused for saying a few words. In the first place they all knew there was not such a society as the Entomological Society of Great Britain; if there were, it would be the duty of the President of that body to return very hearty thanks to the people who had said things in such a kindly way about the English nation. But he had the honour to represent, he believed, the largest, and—the Fellows thought, at any rate—the most important society in these islands. He had extremely pleasant recollections of his personal relations with entomologists on the Continent, ever since he commenced to study, and he was proud to have the honour of being intimately acquainted with the great entomologists of almost every nation. This was the first occasion on which he had really had the pleasure of meeting any considerable number of their friends from across the Atlantic, and he was certain that the kindness which existed between entomologists of different countries in Europe was quite equalled by the kindness which was shown by entomologists from the United States (applause).

The President said he was sure the company, before separating, would like to hear a few words from the originator of the conception of the International Congress, Dr. JORDAN.

Dr. JORDAN (Tring) said at this late hour it was quite unnecessary for him to say much, but this he would say—that the Congress had already achieved its idea of bringing together friends (applause). At Brussels many of them met for the first time, and now here in Oxford the friendship which sprang up at their first International Congress had been renewed and strengthened. Some entomologists in their researches were very much in favour of one theory, while others were equally in favour of another, but all their studies were really directed to the same point—they wanted to know the inner cause of what they were studying, they wanted to know what lay behind the variation, behind the differences between the species. Let them strive to get as accurate a knowledge of the science they were studying as they could, and let them bear in mind that they were not only working for this generation, but also for those who were to follow them (applause).

The company then dispersed.

SATURDAY, AUGUST 10TH.

Practically the whole of the members of the Congress accepted the kind invitation of the Hon. W. ROTHSCHILD to visit his private Zoological Museum at Tring. A special train was arranged to leave Oxford at 8.35 a.m. The railway tickets having been on sale at the office of the Congress during the week, no time was lost at the station. For the convenience of those members (the large majority) who wished to proceed to London later in the day, it was arranged that a luggage van should be attached to the train, and should remain at Tring during the day, being subsequently attached to the 4.52 train from Tring to London.

At Tring Station the party was met by a number of conveyances, which conducted the members to the Museum.

The Editors are indebted to Mr. H. ROWLAND-BROWN for the following account of this memorable visit :

The formal business of the Congress was concluded on Friday, August 9th, but members were invited *en masse* to Tring by the Hon. WALTER ROTHSCHILD. The rendezvous was exceptionally convenient for the many returning that day to London *en route* for the Continent, and 130 guests sat down to lunch in the Victoria Hall, to enjoy the spacious hospitality offered them there. Meanwhile, the party had been received in the Museum itself, where Mr. WALTER ROTHSCHILD delivered a short speech of welcome in French, German, and English, laying special stress on the debt of gratitude he owed to his old friend and counsellor, the naturalist Dr. ALBERT GÜNTHER, to whom he owed his first resolve to devote his life to the study of Nature in general, and of birds and butterflies in particular. We were then conducted through the several magnificent collections by Dr. KARL JORDAN and others, whose names are so closely associated with the work done for Entomology at Tring. Especially interesting were the exhibits

of Ornithoptera, and other Lepidoptera recently brought to the knowledge of the scientific world from New Guinea and the Indian Archipelago ; the models for Mr. ROTHSCHILD'S and Dr. JORDAN'S classic work on the Sphingidæ, and the rest of the original material with which entomologists have been made familiar by the publication of the *Novitates Zoologicæ*. Later in the day, and after a photograph had been successfully taken of the attending members, we were left at liberty to admire Lord ROTHSCHILD'S beautiful gardens at Tring Park, and to wander in the Park which surrounds this charming mansion of the Restoration period ; and it was well on towards evening before, the guests having said good-bye to our host, the special train entered the station, and the last and one of the most delightful phases of the International Congress of Entomology came to an end.

EXHIBITS.

The following exhibits were made at Oxford, and the respective exhibitors attended at various convenient times to furnish explanations and information.

I.—DR. F. A. DIXEY, F.R.S.

The Pierinæ.

A special exhibition of butterflies belonging to the subfamily *Pierinæ* was arranged. The exhibition was contained in about 260 cabinet drawers, which were displayed on three long tables in a room situated in the Department of Zoology, kindly lent for the purpose by Prof. G. C. BOURNE, F.R.S. It comprised about two-thirds of the whole collection of *Pierinæ* belonging to the Hope Department. To each genus and species a map was attached, coloured to show the geographical distribution. Beside every specimen was placed a label giving precise data of the time and place of capture, with the names of the captor and donor, when known. Corresponding labels were affixed to each specimen. Within the limits of each species, a definite order was observed with regard to locality ; and within each local group the specimens were arranged according to the date of capture. Attention was drawn by special labels to the seasonal variations of a species, where these existed.

The Hope Collection of Pierines is especially rich in forms from the Ethiopian Region, the genus *Teracolus* being especially well represented. In this genus the phenomenon of seasonal dimorphism is very prevalent, and the remarkable differences between the dry-season and wet-season phases of the same species were copiously illustrated in the examples shown.

The exhibition remained open during the whole time of the meeting of the Congress, and was visited by many of the members.

II.—H. ELTRINGHAM.

The Genus Acræa.

Mr. ELTRINGHAM exhibited the greater part of the Oxford collection of examples of the Genus *Acræa*, arranged in accordance with his monograph, which was published just previously to the Congress by the Entomological Society of London. All the specimens had been arranged and labelled under his direction by Mr. A. H. HAMM. The entire collection occupies about 120 standard cabinet drawers, and a figure of the male armature accompanies the series of each species. In nearly every case where the museum does not actually possess an example, a coloured figure is inserted in its proper place, so that the entire series forms a most valuable reference collection. Of some 360 named forms the Hope Department possesses examples of approximately 80 per cent., including over forty types. The exhibitor pointed out the remarkable polymorphism of many members of the genus, together with the extreme differences in some of the "seasonal" forms, and the frequent development of mimetic patterns. Changes in pattern corresponding to geographical distribution were noted, as also cases where widely different patterns were accompanied by remarkable similarity in the structure of the male armature, and instances of the opposite of this condition. Amongst the latter is the remarkable case of *A. mansya* and *A. chambezi*, the species being identical in appearance, with the exception of the position of one small spot, whereas the respective male armatures show nearly as much difference as those of any other species of the genus.

III.—R. S. BAGNALL.

Mr. BAGNALL exhibited new British insects, etc., in the following little-worked groups:

(a) *Thysanura*.—A collection of the British Thysanura, including examples of the recently described *Campodea lubbocki* Silvestri from Oxford.

(b) *Collembola*.—Numerous springtails from the North of England and Scotland, including representatives of about two dozen additions to the British fauna—chiefly subalpine forms,

such as *Tetracanthella*, *Tullbergia* spp., etc. Also the curious and very minute *Megalothorax minimus* and *Neelus minutus*.

(c) *Protura*. British examples of the genera *Accerentulus*, *Acerentomon*, and *Eosentomon*, mostly from the North of England. The Order was diagnosed by Silvestri in December 1907, and monographed by Berlese in 1909.

(d) *Thysanoptera*.—A fairly complete collection of British thrips, including examples of all the recent additions, also the giant *Megathrips nobilis* Bagn., and other types.

(e) *Mallophaga*.—New British bird lice from the fulmar, cormorant, little auk, little owl, pheasant, pigeon, swift, starling, and other birds, including a new *Trinoton* from the teal.

(f) *Myriapoda*.—A collection of British species mostly from the North of England, and including several (over two dozen) new species and representatives of two families and several genera new to Britain. Also types of eight new species of *Symphyla*.

IV.—PROF. POULTON AND MR. A. H. HAMM.

INSECTS AND THEIR PREY: WITH SPECIAL REFERENCE TO THE COURTSHIP OF THE EMPIDÆ.

The following account of this important exhibit has been taken from the current report of the Hope Professor of Zoology:

“No more interesting and valuable addition to the bionomic series has ever been made than the large collection by which Mr. A. H. HAMM, of the Hope Department, has thrown so much light upon the courtship of the Empid flies.

“Results so surprising require abundant proof, and it will be admitted by any one who studies the series that the material, both of *Empidæ* themselves and the insects captured or objects seized by them, is of immense extent and most carefully collected, embodying the results of a large number of original observations and most ingenious experiments. The whole of the researches were carried out in the neighbourhood of Oxford. The great labour of labelling and cataloguing was finished by Mr. COLLINS in time for exhibition at the Entomological Congress in August 1912, where the collection was studied with keen attention and

interest. The catalogue numbers—591 in 1908, 771 in 1909, 718 in 1910, and 969 in 1911—large as they are, give a very inadequate idea of the material; for the catalogue is of mounts rather than specimens, of which many are constantly carried on a single card. The collection includes many specimens captured and presented by Mr. HAMM's son, Mr. C. H. HAMM.

"A part of the results has been already published in the *Entomologist's Monthly Magazine* for 1908, p. 181, and 1909, pp. 132 and 157; but the most novel and interesting observations and conclusions—those obtained with the genus *Hilara*—are made known for the first time in the following brief account of Mr. HAMM's gift. The full and detailed account awaits publication until numbers of obscure and minute insects—Dipterous captors and prey chiefly Dipterous—have been satisfactorily worked out.

"The collection has been classified by Mr. HAMM so as to illustrate his conclusions, the species being arranged in groups, each representing a definite evolutionary stage in the use of prey—first and lowest as food devoured by both sexes without relation to pairing; then as a gift provided by the male and devoured by the female during pairing; finally, as it were an ornament or plaything—no longer eaten by the female, but acting as a lure and a stimulus. In this last stage the prey is often replaced by some vegetable fragment which is quite unsuitable as food. The climax of this line of evolution is reached in an elaborate cocoon spun by the male around the prey and replacing the latter as an object of attraction. This replacement is self-evident in many examples studied by Mr. HAMM; for in these there was nothing but an empty cocoon, the prey having probably been lost during the process of construction.

"There are strong reasons for the belief that the last stage has been reached through the second and the second through the first, but this inference must not be extended further and made to apply to the species themselves.

"EMPIDÆ AND THEIR PREY IN RELATION TO COURTSHIP.

"1. Prey devoured by both sexes independently of pairing.

"(a) *Tachydromia* (*Tachydrominæ*).—Prey very nearly always Dipterous and often belonging to the genus *Tachydromia*, perhaps sometimes to the same species as the captor. The female

in copulâ has very rarely been found with prey. 1908—ninety catalogued specimens (or mounts) of which seventeen were captured by Mr. C. H. HAMM; 1909—eighty-six, of which two were captured by Mr. C. H. HAMM; 1911—thirty.

“(b) *Hybos* (*Hybotinæ*).—Prey generally Hymenopterous. 1908—eighty-four, of which twenty-six were captured by Mr. C. H. HAMM; 1909—two; 1911—six.

“(c) *Empis trigramma*, *punctata*, and *scutellata* (*Empinæ*).—A little group of related species with habits very different from those of the rest of the genus, so far as it has been studied. 1909—sixty-three.

“2. The prey provided by the male is devoured or sucked by the female during copulation.

“(a) *Pachymeria* (*Empinæ*).—The prey always Dipterous. 1908—one hundred and ten; 1909—one hundred and seventy-eight.

“(b) *Rhamphomyia* (*Empinæ*).—The prey nearly always Dipterous. 1909—three; 1910—two hundred and fifty; 1911—sixty-five.

“(c) *Empis* (*Empinæ*).—Small species as yet undetermined. Prey nearly always minute Diptera, chiefly *Cecidomyia* and *Psychodes*. 1909—two; 1910—fifty-five; 1911—one hundred and three.

“(d) *Empis tessellata*.—Prey very varied, but always Dipterous. 1908—two; 1909—two hundred and twenty-four; 1910—twelve; 1911—thirty-three.

“(e) *Empis opaca*.—Prey like that of *tessellata*, but mainly of the genus *Bibio*. 1909—one hundred and sixty-eight; 1910—forty-six; 1911—forty.

“(f) *Empis livida*.—Prey more varied than that of any other species, but still chiefly Dipterous. 1908—three hundred and five, of which four were collected by Mr. C. H. HAMM; 1909—forty-five; 1911—thirty-two.

“3. The prey or object provided by the male is not devoured by the female, but becomes as it were an ornament or plaything providing some indispensable stimulus.

“(a) *Hilara* (*Empinæ*).—Many species as yet undetermined. All the species fly over water, and the prey or other object is always picked up from its surface by the male *Hilara*. The

males take floating insects of all kinds—sometimes specially Diptera, sometimes Aphids—scales off overhanging trees or other fragments of plants. Some of the species will accept almost any floating object, while others seem to restrict themselves to particular insects, such as *Aphidæ*. When the object is very heavy the male, after seizing it, spins round with great velocity till the load rises on a cone of water and is finally lifted from the apex. In Mr. HAMM's experiments disabled Diptera of the genus *Chironomus*, etc., stamens of buttercups, and ray florets of daisies strewn on the water were soon taken by the males and afterwards found in the possession of the females. Pairing invariably occurs upon the wing, but numbers of specimens show that a sweep of the net through the swarm at first catches nothing but males carrying the objects that had been strewn on the water, while a later sweep catches pairs still carrying the same objects. The specimens illustrating the investigation are all carefully labelled with the hour and minute at which the different samples were secured.

“Mr. HAMM's admirable experiments also enabled him to determine that the females carry the objects provided by the males; for although they are never retained when the pairs are captured, the white florets or the yellow stamens can be seen hanging from the lower *Hilara* of each flying pair, and the lower is invariably the female.

“The climax is reached in the males of certain species of *Hilara* which envelop the prey or other minute object in a cocoon, varying greatly in complexity, but in the most extreme cases of striking beauty and regularity. The cocoon is spun upon the wing, so that the method of its construction cannot be followed. Captured individuals are often found to have extruded a viscid globule—probably the material out of which the cocoon is spun. There can be little doubt that in these extreme cases it is the cocoon itself which acts as a stimulus to the female, although the minute and almost invisible object usually enclosed in it, but sometimes dropped, is the stimulus which incites the male to spin. Cocoons that have been dropped, probably after pairing, are constantly picked up and used over again by other males.

“These novel and surprising conclusions, obtained as the outcome of Mr. HAMM's energy, resource, and power of accurate observation, are illustrated and confirmed by an immense mass

of mounted material, catalogued under 355 numbers in 1910 and no less than 660 in 1911."

V.—PROF. POULTON.

Prof. Poulton exhibited some of the Bionomic Collections, of which the following is a short account :

The Bionomic Collections are in many respects the principal feature of the Hope Department. It is only possible to enumerate the chief groups under which the very extensive material is arranged :

1. Examples of procryptic defence, especially among butterflies. Under this head may be placed A. H. THAYER'S beautiful model showing the meaning of the white undersides of animals. This model is in the central court of the museum, on the ground floor.

2. Models and their mimics captured on the same day by the same naturalist. These are principally Ethiopian, and are due to the kind help of G. A. K. MARSHALL, Rev. ST. AUBYN ROGERS, S. A. NEAVE, W. A. LAMBORN, G. D. H. CARPENTER, and especially C. A. WIGGINS.

3. Mimetic associations in the different zoological provinces, a special feature being the American *Papilio* mimics of the distasteful *Aristolochia* *Papilios* (*Pharmacophagus*), the Ithomiine-centred combinations of S. America, and the Ethiopian combinations. The principal material from the Oriental region is the fine series of mimetic associations described and figured by the late R. SHELFORD.

4. Families of dimorphic or polymorphic mimics with their female parents. Chief among these are the families of *Papilio dardanus*, bred by G. F. LEIGH in Natal and W. A. LAMBORN in the Lagos district,¹ and of *Euralias* bred by the late A. D. MILLAR in Natal, and W. A. LAMBORN near Lagos. Associated with these are the families bred by G. F. LEIGH, proving that *Charaxes zoolina* and *neanthes* are the dimorphic forms of a single

¹ Since the date of the meeting, by Dr. G. D. H. CARPENTER in Uganda, and C. F. M. SWYNNERTON in S.E. Rhodesia.

species, and the fine series of *Precis* bred in Mashonaland by G. A. K. MARSHALL, proving the specific identity of the very different seasonal forms found in the African species of this genus. In many of MARSHALL'S experiments, and in those of Col. MANDERS in Ceylon, the effects of artificial temperature and humidity were tested.

5. The large amount of material in which the Mendelian relationship has been tested :

(a) British species of the PROUT-BACOT-ALEXANDER experiments on *Acidalia virgularia*, and of many other experiments made by A. BACOT.

(b) Ethiopian species tested by the Rev. K. ST. AUBYN ROGERS and W. A. LAMBORN.

6. The large amount of indirect evidence of attacks made upon butterflies, furnished by the injuries to the wings of fresh specimens. This material, principally Ethiopian, is mainly due to MARSHALL, LAMBORN, and Dr. G. B. LONGSTAFF. Associated with it are specimens showing directive marks diverting the attention of an enemy from the vital parts, and the injuries commonly found at such spots. These were principally collected by MARSHALL and by LONGSTAFF, who has made a special study of attitudes, especially in the *Lycænidæ*, serving to display these features.

7. Specimens in which scents—sexual, in the males ; probably aposematic, in both sexes—have been detected, principally by Dr. F. A. DIXEY and Dr. G. B. LONGSTAFF.

8. Predaceous insects and their prey, illustrated by a very large collection, principally of *Asilidæ* and *Empidæ*. We here probably meet the chief enemies (except parasites) of the distasteful species. This material has been collected by a large number of naturalists, the British especially by Col. J. W. YERBURY and A. H. HAMM.

9. The material figured in published plates. Each set of specimens is maintained in its original order beside a copy of the plate itself, thus facilitating the study of the original memoir. This method of display has been applied especially to the Ethiopian material, and also to the many mimetic combinations among Bornean insects described by the late R. SHELFORD.

The following series of specimens are associated with the Bionomic Collections:

1. Specimens showing exceptional means of distribution over the ocean.
2. Special faunas, of interest from many points of view, but principally bearing upon distribution and isolation, such as the butterflies of New Zealand, the southern part of S. America, and the Canary Islands.
3. A series showing a comparison between Island forms and the most nearly allied species on the adjacent continent, at present only illustrated by specimens, arranged by Dr. LONGSTAFF, from Jamaica and Central America.

In addition to the specially announced exhibits the Hope Department was open during the entire week for the benefit of those wishing to inspect any portion of the extensive collections, and Mr. A. H. HAMM and Mr. J. COLLINS rendered every assistance to the many visitors who took advantage of the opportunity. The greater part of the following account of the origin and work of the Department appeared as a supplement to the guide-book, having been specially written by Prof. POULTON.

The Hope Department originated in the year 1849, when the Rev. F. W. HOPE, of Christ Church, presented his Zoological Collections, Library, and Engravings to the University, and appointed JOHN OBADIAH WESTWOOD as Keeper. The deed of gift was approved in 1850, and the Collections at once attracted much interest. The Visitors' Book opens with twenty signatures, principally of members of the University, under the date June 12th, 1850. A MS. inventory, drawn up by WESTWOOD in 1857, mentions the contents of the 903 cabinet drawers in which the Hope Collection of insects was contained, and gives an account of the Westwood collections, library, and drawings purchased and presented by Mr. HOPE, and of other donations. A paper printed by WESTWOOD as Keeper, and dated January 1860, from the Taylor Institution, states that "additions to a large extent have annually been made by the donor to his gift, in each of its three branches," that the collections other than the Arthropoda had recently been transferred to the Ashmolean Museum, and that the Arthropoda, together with "the finest entomological library in existence," remained in the Taylorian, "awaiting

removal to the rooms prepared in the New University Museum "—a transference contemplated in the original deed of gift. It was probably in connection with the migration to the Parks that the Rev. F. W. HOPE founded the Hope Chair in 1861, and appointed WESTWOOD as first Hope Professor. The founder died in 1862, and in the same year, and again in 1864, his widow added to the endowment of the Chair the collections, library, and engravings, and founded the Hope Keepership of engraved portraits.

At the time of Prof. WESTWOOD's death, in 1893, the University provided a small annual grant for an assistant. It now provides for the remuneration on a more adequate scale of two assistants, increased to three as the result of Dr. G. B. LONGSTAFF'S endowment in 1909. A portion of the Magdalen College grant, administered by the Delegates of the Museum, augmented later by an annual grant from the Common University Fund, made possible the appointment of the late R. SHELFORD as Assistant-Curator in 1905, and of R. S. BAGNALL in the present year. Jesus College, by electing the Professor to a Fellowship on the understanding that the annual income would be devoted to University purposes, has benefited the Department in many ways, especially in the provision of cabinets. The expense of this latter costly requirement has also been shared by grants from Brasenose College, the Common University Fund, Convocation, and by private contributions. A sum of £100 was presented by Dr. H. WILDE, F.R.S., towards the expense of creating the Bionomic Collections.

It was at first intended to place the Hope Department in the west upper corridor of the University Museum, but this space was required for the Radcliffe Library. The Department was ultimately given the western half of the south upper corridor, the northern section being handed over to the two Mathematical Professors. In 1893, when the present Professor was appointed, the University made arrangements for extending the Department into this latter section; and now, nineteen years later, it has just been extended into the southern half of the space originally intended for it, the Radcliffe Library having been transferred a few years ago to the Drapers' Building. During the first Professor's occupancy of the Chair, from 1861-93, the collections were immensely increased. The founder presented the Wollaston

Madeiran Coleoptera in 1861, and his widow the Canarian series in 1863. Mrs. HOPE also presented one of the most important gifts ever received by the Department, viz. the collections of Lepidoptera—Heterocera, Orthoptera, and Economic Entomology, purchased in 1873 from W. W. SAUNDERS, the two first-named being very rich in types, especially of WALKER and BATES. The Saunders Collection of Hymenoptera, specially valuable for its many types of F. SMITH, was purchased in 1875 out of the Hope endowment, as also the large collection of Greek Hymenoptera made by Sir SYDNEY SAUNDERS. Other important collections received during Prof. WESTWOOD's occupancy of the Chair were: the Tylden Collections, principally of *Curculionidæ*, presented by Mrs. TYLDEN; the Miers Collection, principally of Coleoptera from the Rio de Janeiro district; the A. R. Wallace private collection of certain Malayan groups of insects; and the historic W. J. Burchell Collection of Arthropoda, principally insects, from Africa (1810–15) and Eastern Brazil (1825–30), presented by Miss ANNA BURCHELL in 1865. Prof. WESTWOOD bestowed a great deal of work upon this last collection, and prepared a MS. catalogue of a large part of it. He also himself presented many collections, including the important Bell Crustacea, to the Department.

It would be impossible to do justice to the labour expended on the Hope Collection by the late Professor. But mention must be made of the great monograph, *Thesaurus Entomologicus*, in which many of its principal treasures are described and figured, and of the *Revisio Insectorum Familiæ Mantidarum*, published nearly at the end of his life.

Since 1893 many very valuable additions have been presented, and assistance in working out the material has been granted in an ever-increasing measure. The principal accessions have been: the great series of duplicate Lepidoptera—Rhopalocera, Coleoptera, Rhynchota, and Orthoptera from the Godman-Salvin Collection, chiefly from the Neotropical Region, especially Central America, and from the Solomon Islands, presented by Dr. F. D. GODMAN, F.R.S., and the late O. SALVIN, F.R.S.; the Rothney Library and Collection of Oriental Hymenoptera, rich in Cameron types, presented by G. A. J. ROTHNEY; the Prior Collection of Bornean Rhopalocera, presented by Mrs. W. B. PRIOR; the

Burr Collection of Orthoptera, presented by Dr. MALCOLM BURR; the F. P. Pascoe Library and a large part of the Pascoe Collection, presented by Miss PASCOE; from the Van de Poll Collection, the Chevrolat and Baden-Sommer Coleoptera, the Orthoptera, and a collection of Malayan Rhopalocera, presented by the Professor; and the Hymenoptera, by G. A. J. ROTHNEY.

In addition to the above collections, presented as a whole, the Hope Department has been rapidly accumulating extensive collections made in recent years in various parts of the world, especially Africa. The principal naturalists who have contributed material from this continent are: C. N. BARKER, F. N. BROWN, H. A. BYATT, G. D. H. CARPENTER, W. A. LAMBORN, G. F. LEIGH, G. A. K. MARSHALL, the late A. D. MILLAR, S. A. NEAVE, the Rev. K. ST. AUBYN ROGERS, C. F. M. SWYNERTON, and C. A. WIGGINS. The chief areas represented by the collections of these naturalists are: Natal, Rhodesia (both North and South), British Central Africa, British East Africa, Uganda, and the Lagos district of West Africa. From these parts the Hope Collection probably possesses more extensive and more instructive material than any other museum. A large part of the African material has been specially collected in order to throw light upon bionomic problems, such as Mimicry, Warning Colours, Protective Resemblance, and the alternation of seasonal forms. Great collections from many parts of the world have been presented by HERBERT DRUCE, Dr. G. B. LONGSTAFF,¹ and Commander J. J. WALKER, from Borneo by the late R. SHELFORD, and from Majorca by the Professor, A. H. HAMM, and W. HOLLAND.

It is only possible to mention specially the principal help that has been generously given in the labour of working out the University Collection. Dr. F. A. DIXEY, H. ELTRINGHAM, and the late R. SHELFORD have made their respective groups, the *Pierinæ*, the *Acræinæ*, and the *Blattidæ*, the most perfectly arranged and instructive of any in existence. Dr. LONGSTAFF has not only worked out his own material, but has also with great

¹ An account of Dr. LONGSTAFF's collections will be found in his *Butterfly Hunting in Many Lands* (London, 1912).

labour prepared manuscript lists of the *Hesperidæ* and *Satyrinæ* of the British Museum. The extensive collections of *Lycænidæ* and *Hesperidæ* have been named and arranged by H. H. DRUCE, the Oriental moths by Col. C. SWINHOE, the Coleoptera Phytophaga by the late M. JACOBY. Much kind help has continually been afforded by the staff of the British Museum, by the Hon. WALTER ROTHSCHILD and Dr. KARL JORDAN of the Tring Museum, and by members of the Council of the Entomological Society and other naturalists who have accompanied them on the summer visits by which the Department has so greatly profited.

The collections of British insects form an important feature of the Department. To the well-known Hope-Westwood collections have been added, first, in 1878, the Spilsbury Lepidoptera; more recently, the historic J. C. Dale Collection, bequeathed by the late C. W. DALE; the extensive A. J. Chitty Collection, presented by the late Mrs. CHITTY; the Coleoptera presented by H. ST. J. K. DONISTHORPE and by W. HOLLAND; the Diptera presented by Col. J. W. YERBURY; the Hymenoptera presented by G. A. J. ROTHNEY; and the Edward Saunders Hemiptera and Homoptera. The efficient state of the British Hymenoptera Aculeata is due to the help of the late EDWARD SAUNDERS, F.R.S.; of the Diptera to Col. YERBURY, the late G. H. VERRALL, and J. E. COLLIN; and of the Coleoptera to Commander J. J. WALKER.

During the past nineteen years an immense amount of mechanical labour has been expended upon the collections briefly mentioned above, the old as well as the new. Thus, vast numbers of the old specimens, including the whole of the butterflies, have been re-pinned and re-set, while the accessions have been provided with printed labels, recording fully the data of time and place, together with other details whenever available. Such success as has been achieved has only been rendered possible by the efficient and loyal help of the assistants in the Department, A. H. HAMM, J. COLLINS, and the late assistant, W. HOLLAND.

Much time has been spent upon the entomological library and its large annual accessions, especially of separata. With the efficient help, at first of Miss BELLAMY, later of Miss SHELFORD and R. SHELFORD, a card catalogue has been nearly completed.

A considerable amount of labour is devoted to the yearly reports, which are a special feature of the Department. The researches conducted in the Department or upon its material are published through various scientific societies and journals, but separata are struck off and bound, and issued for private circulation from time to time. The seventh volume of the Report appeared in 1910, and the materials for an eighth are in hand.

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The following, now deceased, also was a life-member of the Entomological Congresses :

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The names of Members and Associates present are printed in *italics*.

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Obituary.

G. H GROSVENOR.

THE sad news of the untimely death of Mr. G. H. GROSVENOR came as a great shock to the members of the Entomological Congress. Previously to that meeting he was doubtless known to many of the members only by reputation, but he quickly found for himself a high place in their regard. Acting as Joint Secretary of the Oxford Committee, he assisted in the whole organisation with the same quiet courtesy and efficiency which characterised all his undertakings. After the close of the Congress he went on a visit to his sister and brother-in-law, who were staying at Polzeath, in Cornwall, and on September 4th he was drowned in a heroic but unsuccessful endeavour to save the life of a friend.

GEORGE HERBERT GROSVENOR was the eldest son of Mr. G. W. GROSVENOR, D.L., of Blakedown, near Kidderminster, and was born in 1880. He was head boy of Mr. E. B. HAWTREY'S Preparatory School at Westgate, and from there took a classical scholarship to Harrow in 1894. At Harrow he was successively head of each form until he took his place in the sixth. For more than a year he was head of Mr. BOWEN'S house, and was especially distinguished in mathematics. He was awarded the Beddington Chemistry Prize, and taking up the study of biology shortly before leaving school he obtained a biological scholarship at New College, Oxford. In 1902 he took a first class in Natural Science, and was chosen to occupy the Oxford Table at the Naples Marine Biological Laboratory. Here, by a brilliant piece of research, he confirmed

STRETHILL WRIGHT's half-forgotten suggestion that the nematocysts of *Æolids* are derived from their prey. He also worked on heredity in *Salpa democratica mucronata*. For these papers, of which the former was read before the Royal Society, he was awarded the Rolleston Prize in 1904. At Oxford he was appointed Demonstrator in Zoology, and when the Indian Woods and Forests College was transferred to that University, he became lecturer in Economic Entomology. For five years he took the Easter Vacation class in Marine Biology at Plymouth Laboratory, and the fact that during that time his class rose from six to fifty bears sound testimony to his popularity and success as a teacher.

In 1911 he was awarded a Carnegie scholarship, under the auspices of the Entomological Research Committee of the Colonial Office, and visited the principal research laboratories in the United States of America. At the time of his death he was engaged on a monograph of the African *Braconidae*, and it is hoped that at least a portion of this may yet be published. He was of a singularly modest and retiring disposition, and those whose privilege it was to know him intimately could best appreciate the charm of his personality. Even for so young a man he had published but little. He loved his work for its own sake, rather than for any fame it might bring him. Possessed of an extremely logical and analytical mind, he never allowed his interest in a theory to obscure the force of an opponent's argument, and his share in any discussion always evinced a singular clearness and rapidity of thought. Had he lived, high honours undoubtedly awaited him, yet life itself could not have conferred that greatest honour in which his name must henceforth be held.—H. ELTRINGHAM.

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THE TRANSACTIONS OF THE SECOND ENTOMOLOGICAL CONGRESS, 1912.

THE SILK OF SPIDERS AND ITS USES.

By JOHN HENRY COMSTOCK, ITHACA, N.Y., U.S.A.

(Plates III, IV, and V.)

WHILE silk is produced by the representatives of many orders of animals, it is in the order ARANEIDA that the production of this substance has reached its highest development. Not only do spiders produce much silk, but they use it for widely different purposes; and there have been developed in these animals several different types of silk glands, each of which produces a special kind of silk, fitted for a particular use.

The most extended study of the silk glands of spiders that has been made is that of APSTEIN (1889). This writer showed that at least seven different types of silk glands are to be found in spiders, although no spider possesses all of them. These glands are designated respectively as the aciniform, pyriform, ampullate, cylindrical, aggregate, lobed, and cribellum.

In the four-lunged spiders only the pyriform glands have been observed; but only a very limited amount of study has been devoted to the silk glands of these spiders. In all two-lunged spiders studied, three of the seven types of glands have been found; these are the aciniform, pyriform, and ampullate. A fourth type, the cylindrical, is wanting in only two families, the *Attidæ* and the *Dysderidæ*. The three other types of glands are each characteristic of a particular group of spiders. The

aggregate glands are found in the *Argiopidæ*, *Linyphiidæ*, and *Theridiidæ*; the lobed glands, only in the *Theridiidæ*; and the cribellum glands in the CRIBELLATÆ. Each of these three groups of spiders that possess a characteristic type of silk gland possesses also the first four types mentioned above; hence the presence of five types of silk glands in a single species is common.

The form and structure of each of these types of silk glands have been described by APSTEIN; for the purposes of this paper it is only necessary to call attention to the fact that the aciniform and pyriform glands are small and very numerous, while the other types of glands (except the cribellum glands) are much larger and quite limited in number.

Correlated with the differentiation of the silk glands into several types, there have been developed several different types of spinning organs. Each gland opens through a spinning tube; but the different sets of glands open through different kinds of tubes. Omitting the characteristic details of form distinguishing the different types of spinning tubes, they can be grouped into two kinds: first, the small spinning tubes through which the numerous aciniform and pyriform glands open; and second, the much larger spinning tubes, termed spigots, through which the larger and much less numerous glands open. The exceedingly small pores through which the cribellum glands open might be considered as a third type.

In addition to these specialized outlets of the silk glands, we find that in certain families of spiders there is an organ for manipulating the silk after it leaves the spinning tubes; this is the comb on the hind tarsus in the *Theridiidæ* and the calamistrum on the metatarsus of the hind legs in the CRIBELLATÆ.

Before entering upon the account of the different kinds of silk spun by spiders, it is necessary to clear the way by reference to a wide-spread error concerning the structure of the most commonly observed threads.

The fact that the spinnerets bear many spinning tubes which serve as outlets of the numerous spinning glands, led the early writers to conclude that the ordinarily observed threads were each composed of many minute threads united. This view was held till 1890, when WARBURTON pointed out that the dragline

and the dry threads of webs are composed of only two or four strands, each of which issues from the type of spinning tube now known as a spigot.

The most general use of silk by spiders is for the protection of their eggs ; and it is not improbable that this was the primitive use of this substance by these animals. But having acquired the ability to produce silk, it was natural that it should be put to other than its original use, for it is a substance that is available for many different purposes.

In the present state of our knowledge, an attempt to trace the steps by which the several kinds of silk glands, producing silk fitted for widely different purposes, have been evolved from the primitive type of silk gland, would be largely hypothetical, and I will not presume to undertake it. But I confidently believe that such a study would throw much light on the phylogeny of the families of the ARANEIDA.

The different kinds of silk produced by spiders can be grouped into three classes : first, silk consisting of very many, extremely slender strands ; second, silk consisting of a small number of comparatively large strands ; and third, a more or less fluid, viscid silk.

The first of these three classes of silk, that consisting of very many, extremely slender strands, is produced by the pyriform and the aciniform glands, which are present in large numbers, and which open through the small type of spinning tubes. These are the spinning tubes that have been most often observed and described.

From the pyriform glands, which open through the small spinning tubes of the fore spinnerets, are spun the attachment disks, by means of which the larger threads are fastened to various objects. Each attachment disk (Pl. III, fig. 1) consists of many exceedingly fine loops, and is made by applying the fore spinnerets to the object upon which the disk is to be made, and by alternately spreading apart and bringing together these spinnerets the looped threads are drawn from the small spinning tubes. This operation was described by APSTEIN and can be easily observed by enclosing a living spider in a bottle, and watching it with a lens as it fastens its dragline to the side of the bottle.

The chief use of the silk spun from the aciniform glands, in the case of the orb-weaving spiders at least, is the production of what may be termed the swathing band, the band of silk with which these spiders envelop their prey. The act of swathing can be easily observed by throwing a large insect into the web of one of the larger of the orb-weaving spiders. The spider first rushes at the insect and pierces it with the claws of its chelicerae, and then darts back into a position of safety. This may be repeated several times; or, if the spider is not afraid of its victim, the biting may be omitted. Then the spider approaches the insect and, pulling out a sheet of silk from its spinnerets, with one hind leg thrusts the sheet against the insect. In doing this the spider uses first one hind leg and then the other. In the case of the larger spiders this sheet of silk is sometimes an inch in length, the body of the spider being held that far from the insect; under these conditions the sheet can be seen to be composed of a very large number of parallel threads. As soon as the sheet is fastened to the insect the spider rolls the insect over and over and thus wraps it in its shroud.

I have observed the making of the swathing band many times, but owing to the timidity of the spiders observed, I have never been able to determine to my complete satisfaction whether the silk comes from all of the spinnerets or only from the hind and middle ones. If it comes from only the hind and middle spinnerets it is the product of the aciniform glands alone, but if it comes from all of the spinnerets, which it appears to do, it is the product of both the aciniform and pyriform glands.

In addition to the attachment disks and the swathing bands, there are other structures that are evidently spun from the small spinning tubes, and are consequently the product of either the pyriform or the aciniform glands, or of both. Among these may be mentioned the stabilimentum, the zigzag ribbon of silk which some orb-weavers spin across the centre or below the hub of their webs. Fig. 2 represents the more common type of stabilimentum, and shows well that it is composed of many fine threads. The young of *Metargiope* spin a much more elaborate stabilimentum, which is lacelike in form (Pl. III, fig. 3).

Many spiders build retreats which are evidently formed of

silk from either the pyriform or aciniform glands. The retreat of *Aranea thaddeus* (Pl. III, fig. 4) is a good illustration of this.

The most familiar illustration of the second class of silk, that consisting of a few strands of comparatively large size, is the dragline spun by most spiders wherever they go. This ordinarily consists of two strands, and is spun from the ampullate glands, as was first determined by Warburton. Fig. 1 represents an attachment disk with the dragline leading from it. This line is the thread that forms the principal part of the webs of spiders. In orb-webs, the foundation lines and the radii are made of it.

Another kind of silk consisting of a few strands of considerable size is the foundation thread of the viscid spiral. This resembles the dragline in consisting of two strands, but differs, as is well known, by its great elasticity. It is evident that this elastic line is spun from two spigots. And by a process of elimination we can infer that it is spun by one of the two pairs of ampullate glands possessed by the orb-weavers.

The threads of which egg sacs are composed also consist of a small number of comparatively large strands; but the number of the strands is greater than in the kinds of silk produced by the ampullate glands, being six or more in all that I have examined. It has been well established that this silk is produced by the cylindrical glands.

Of silk that is evidently spun from spigots there remains to be mentioned the supporting strands of the viscid threads spun by the cribellate spiders. Of the source of these nothing definite has been determined by direct observation. But I venture to suggest that these strands are spun from the ampullate glands. In *Amaurobius*, which was studied by APSTEIN, and which can be taken as a type of the CRIBELLATÆ, the only glands that open by spigots are the ampullate and the cylindrical. Hence these large threads must be spun from one of these sets of glands. As the well-known function of cylindrical glands is the production of the threads of which the egg sac is made, there remain only the ampullate glands from which these strands could be derived.

I have suggested that with the typical orb-weavers, the *Argiopidae*, where there are only two pairs of ampullate glands,

the dragline is derived from one pair, and the elastic strands of the viscid line from the other pair. In *Amaurobius* there are three pairs of ampullate glands, and in the viscid thread, as will be shown later, there are two pairs of supporting strands. If one pair of ampullate glands produce the dragline of these spiders, there remain two pairs of ampullate glands, from which the two pairs of supporting strands of the viscid thread may be derived.

Let us pass now to a brief study of the more or less fluid viscid silk.

The simplest form of this silk is what may be termed the swathing film of the *Theridiidæ*. This silk is emitted from two or four spigots, one or two, as the case may be, on each of the hind spinnerets. These spigots are the outlets of the lobed glands, which have been found only in this family. The swathing film is flung by these spiders over their prey by means of a comb of hairs on the tarsus of the hind legs, the presence of the lobed glands and the tarsal comb being distinctive characteristics of this family.

Except in the *Theridiidæ*, those spiders that secrete viscid silk place it upon a supporting thread or band of threads. The simplest form of this type of silk is the viscid spiral line in the webs of the *Argiopidæ*. The structure of this viscid line is well shown by Fig. 5, which is a photomicrograph of a short section of thread.

This thread is composed of two elements—the elastic supporting thread which consists of two strands, already discussed, and a series of fluid, viscid drops. It is believed that this fluid viscid silk is secreted by the aggregate glands, as these glands are found only in those spiders that produce this type of thread. I have watched the making of this viscid thread, and have seen that at first the viscid silk forms a continuous coating on the supporting strands: this was while the thread was being pulled from the spinnerets by one of the legs. During this time it was greatly stretched, being several times as long as the space between the two radii upon which it was to be placed; after the thread was fastened to the second radius, it was allowed to contract by the withdrawal of the leg, and as soon as the tension was relaxed the coating of viscid silk collected in drops.

The members of the families constituting the CRIBELLATÆ—that is, those spiders having a cribellum and a calamistrum—spin viscid threads that are distinctively characteristic in being flat and more or less ribbon-like structures. To threads of this form I have applied the term **hackled bands**.

The structure of the hackled bands differs in different families, and sometimes in different genera of the same family. But in all that I have examined the band consists of two elements: first, two or four longitudinal strands, the supporting part of the band—this may be termed the **warp**; and second, a viscid, sheet-like portion supported by the warp—this may be termed the **woof**.

The hackled bands that most closely resemble the viscid thread of the *Argiopidæ* are those spun by members of the *Uloboridæ*, whose webs also bear a striking resemblance to those of the *Argiopidæ*. In these webs the hackled band occupies a similar position to that occupied by the viscid thread of the *Argiopids*; but the method of fastening it to the radii is different. This is well shown in the web of *Hyptiotes*, where it can be seen that the hackled band is attached lengthwise to each radius.

The structure of the hackled band of *Hyptiotes* is shown by Fig. 6. It consists of a warp of two straight strands, which support a series of overlapping lobes of viscid silk. It is evident that this silk is much less fluid than that of the *Argiopids*, for it retains its form, which was probably given to it by the combing action of the calamistrum. It is inferred that this viscid silk is produced by the cribellum glands.

The hackled band of *Amaurobius* (Pl. IV, fig. 7), which can be taken as an illustration of that of the *Dictynidæ*, differs markedly from that of *Hyptiotes*. In this band the warp consists of four strands, two of which are straight, and two are greatly curled. The woof is a wide, flat sheet of viscid silk, the margins of which have a wavy outline. But there is little to indicate that this silk owes its form to a combing action of the calamistrum, as is the case in the hackled band of *Hyptiotes*. It may be that the two curled threads of the warp owe their form to this action, but I think this is hardly probable: the loops in these threads are so numerous that it would require an exceedingly rapid

motion of the calamistrum to produce them. It seems more probable that the structure of these strands is such that they curl naturally, like the hair of a negro.

The most complicated hackled band that I have observed is that made by *Filistata hibernalis*, which is a common house spider in the Southern United States.

Under natural conditions the web of this spider is so quickly injured by insects and obscured by dust that its plan of structure is not easily seen. But this is well shown in some webs that were built by spiders in confinement in my laboratory (Pl. V, fig. 9).

The most characteristic feature of this web is a series of radiating lines, which consist of a double plain thread supporting a looped hackled band. In making these lines the spider spins a thread of plain silk, which consists of several parallel strands, from near the centre of the web to a distant point, where it is fastened by an attachment disk; the spider then returns to the starting-point, spinning as it goes another similar thread closely parallel to the first. Upon these two threads, which serve as a foundation, are fastened afterwards loops of a hackled band. This doubled supporting line and the loops of the hackled band can be seen with the unaided eye.

A small section of one of the radiating lines is shown greatly enlarged by Fig. 8. This picture is from a photomicrograph, and is not as perfect as could be desired; for with the high magnification necessary to see the details it was impossible to get all parts of a loop in focus at once.

Four kinds of silk enter into the formation of this remarkable structure. *First*, the doubled supporting line. *Second*, the primary looped threads; there are two of these, and they form the axis of the hackled band; they are extremely elastic. *Third*, the secondary looped threads; there is one of these, supported by each of the two primary looped threads; each of the secondary looped threads forms a very regular series of loops, each of which is fastened by one end to the primary looped thread; this secondary thread is not looped around the primary thread, as it appears to be, but is merely fastened to one side of it by viscid silk. *Fourth*, the viscid silk; this is an amorphous sheet, which fills the spaces between the loops of the secondary looped

thread ; it is largely liquid, but when it is highly magnified irregular threads can be seen in it.

It is easy to infer the function of these four kinds of silk : the supporting line not only supports the parts fitted for entangling the prey, but communicates to the centre of the web, where the spider is lying in wait, any disturbance of the web ; the primary looped threads also have two functions—they support the secondary looped threads, and by their elasticity allow an entangled insect to become involved in other threads (I have seen these threads stretch to fifty times their first length) ; the secondary looped threads support the viscid silk ; and the viscid silk clings to anything that touches it.

This remarkable hackled band does not differ so greatly from that of *Amaurobius* as would seem at first sight. The supporting thread is a distinct structure, which is spun before the band is made ; it merely supports the band proper, as the dry threads in a dyctinid web support the hackled band of those spiders. Omitting this supporting thread, there remain the four strands of the warp and the viscid silk constituting the woof. The primary looped strands of the warp correspond to the straight strands in the band of *Amaurobius*, and the secondary looped strands to the curled strands of *Amaurobius*.

I at first inferred that the loops of the secondary looped thread were made by the calamistrum ; but this now seems very improbable to me. It is more probable that these loops, like those of the curled thread in the band of *Amaurobius*, are caused by the curly nature of the thread, and as each loop is formed it is held in position by being attached to the corresponding primary looped thread, and by being embedded in viscid silk.

The loops in the primary looped thread are not regular, and are probably merely a result of this thread being slack.

At regular intervals the hackled band is bunched in masses upon the supporting thread. Three of these masses are shown in the figure. The formation of these masses I now believe to be the result of the combing action of the calamistrum. By the formation of these masses a greatly increased quantity of the viscid silk is made available for trapping the prey of the spider.

In conclusion, let me say that this brief sketch is not offered as a complete account of the silk of spiders. I have merely attempted to bring together the more striking features of what I have observed in this field of study, a field that has not yet received the attention it merits.

EXPLANATION OF PLATES III, IV, AND V.

- FIG. 1.—An attachment disc (p. 3).
- FIG. 2.—A stabilimentum, common type (p. 4).
- FIG. 3.—A stabilimentum, lace-like type (p. 4).
- FIG. 4.—Retreat of *Aranea thaddeus* (p. 5).
- FIG. 5.—Viscid silk of *Aranea* (p. 6).
- FIG. 6.—Hackled band of *Hyptiotes* (p. 7).
- FIG. 7.—Hackled band of *Amaurobius* (p. 7).
- FIG. 8.—Hackled band of *Filistata* (p. 8).
- FIG. 9.—Web of *Filistata hibernalis* (p. 8).

THE FOUNDING OF COLONIES BY QUEEN ANTS.

By W. C. CRAWLEY, B.A., F.E.S., and HORACE DONISTHORPE,
F.Z.S., F.E.S.

IT is only within comparatively recent years that anything definite has been known with regard to the origin of the ant colony.

For more than a century this question has occupied the attention of many observers, who, though expressing widely divergent views, have helped by their patient investigation to accumulate evidence without which the present state of knowledge on the subject could not have been reached.

As far back as 1747, WILLIAM GOULD, who may justly be called the father of British myrmecology, actually made an experiment on fertile female ants. In his own quaint language he says: "Upon frequent opening of Mole-Hills, amongst them I met with three, in each of which was a Cluster of large Female Ants, amounting to six or seven in a Cluster. They lay near the Surface, but had no regular Apartment. . . . Upon Dissection several of them had Parcels of Eggs in their Insides. I deposited one of the Clusters in a Box with some Earth, under which they concealed themselves, and united together, but did not work any Lodgment. Some time after, three or four of these Females laid a few Eggs, but did not seem to take any great Notice of them. For Curiosity I placed in the Box a Cell of Workers of the same Species, and it was surprising to observe what Fondness was expressed. The Common Ants immediately surrounded the Females, took care of the Eggs, and in a short Period made an Apartment in the Earth fit to receive them. It may also be observed, that there were no Common Ants in the Hills where I found the above Clusters."

The above is valuable, not only as showing that fertile females were received by strange workers of their own species, but also because it is the first recorded instance of a number of females after the marriage-flight voluntarily associating together and laying eggs.

P. HUBER (1810) carried experiments on fertile females a stage further. He enclosed several fertilized females in a jar full of damp earth, in which they excavated cells. They laid eggs and brought up several fair-sized larvæ, which, however, perished owing to his own neglect.

The first who actually demonstrated that females, after the marriage-flight, are capable of bringing up their brood to maturity unassisted, was Lord AVEBURY, in 1876, whose experiment is referred to in the body of the paper.

It was subsequently assumed that all species of ants founded their colonies in this way. Modern researches have shown that though this is true for the large majority of ants, many species employ very different methods.

Some writers have proposed elaborate classifications of all the different methods of founding a colony, but space does not permit us to discuss them here.

The following table briefly shows all the known methods in which a colony may arise :

I. (*a*) The female ant, after the marriage-flight, removes her wings, seeks a suitable situation, constructs a cell, and brings up her colony alone.

(*b*) Several such females may voluntarily associate and found a colony in a similar manner.

II. The female seeks a nest of another species of ant, is adopted willingly or otherwise by the workers, who bring up her brood. In some manner the host-queen, if present, is eliminated. Then either (*a*) in course of time the host colony dies out, and a pure colony of the female's species remains ; or (*b*) the mixed character of the colony is kept up by means of slave-raids on nests of the host species by the female's offspring.

III. The female is adopted into a colony of another species and lives side by side with the rightful queen. The intruder's offspring of all sexes, but only workers of the host species, are reared together in the nest.

IV. Differs from II. (a) only by the fact that, the species of the alien queen having no worker caste, the colony only lasts for the lifetime of the host workers.

We do not propose to enter here into a discussion as to whether the slave-making habit originated in robbery or parasitism, as such a controversy is not germane to the subject of this paper, which deals only with facts, but we feel bound to refer to DARWIN'S views on the origin of slavery. In a much-quoted passage he writes :

" By what steps the instinct of *F. sanguinea* originated I will not pretend to conjecture. But as ants which are not slave-makers will, as I have seen, carry off the pupæ of other species, if scattered near their nests, it is possible that such pupæ originally stored as food might become developed ; and the foreign ants thus unintentionally reared would then follow their proper instincts, and do what work they could. If their presence proved useful to the species which had seized them—if it were more advantageous to this species to capture workers than to procreate them—the habit of collecting pupæ, originally for food, might by natural selection be strengthened and rendered permanent for the very different purpose of raising slaves. When the instinct was once acquired, if carried out to a much less extent even than in our British *F. sanguinea*, which, as we have seen, is less aided by its slaves than the same species in Switzerland, natural selection might increase and modify the instinct—always supposing each modification to be of use to the species—until an ant was formed as abjectly dependent on its slaves as is the *Formica rufescens*."

This supposition has been much criticised, but it is by no means so inaccurate as has been suggested.

As we shall see later, other species of ants besides the slave-makers do raid strange nests and steal the pupæ for food, and will occasionally actually bring them to maturity. As to the origin of slavery, if DARWIN had known, as we know to-day, that the queen *sanguinea* does not herself found her colony, but from the very first steals the *fusca* pupæ, one of his greatest difficulties would have been removed, viz. the attempt to understand how it is that the workers, which do not normally breed, inherit the slave-making instinct.

NORMAL METHOD.

Subfamily **Ponerinæ**.

Very little seems to have been observed with regard to colony-founding by members of this subfamily. WHEELER, however, records finding isolated females of *Odontomachus clarus* and *hæmatodes* in the act of establishing their formicaries.

Ponera coarctata is often found in the nests of other ants, but according to WASMANN it has no strict connection with them.

JANSON and SHEPPERD both found it in nests of *Lasius fuliginosus*, at Highgate, many years ago. W. E. SHARP took it in a nest of *L. flavus* at Stoa's Nest recently. DONISTHORPE found workers in a nest of *Formica fusca* at Doddington in Kent, 1902, and on September 27th, 1910, took five winged females and a few workers in a nest of *L. fuliginosus* at Darenth Wood. In May 1912 he found a number of workers in a nest of *Formica fusca* at Box Hill. These workers were transferred to two observation nests of *F. fusca*, where they lived for more than two months. They were almost unnoticed by the *fusca* workers, but always crouched down and remained motionless whenever any of the latter touched them. It is possible that females of *Ponera coarctata* may found their small colonies in or near the nests of other species for the sake of the food and shelter they may obtain.

Subfamily **Myrmicinæ**.

It is highly probable that the lethargic ant *Myrmecina graminicola* founds its colonies in the normal way, though very little is known on the subject. CRAWLEY found a deälated female wandering on the flagstones in front of his house near Oxford in August 1897.

A worker was found near the same place a few days later, indicating the presence of a nest, so it is likely that the solitary female was one of those that had left their nest, and after the marriage-flight was seeking a suitable place to establish her family.

DONISTHORPE has in his possession an interesting colony

of this rare species. In May 1910, at Box Hill, he found in a hole in a flint a small colony comprising a certain number of workers, a queen, eggs, and young larvæ. Some days later in the same locality he found a second but smaller colony, also in a hollow flint. From the appearance of these colonies it is exceedingly probable that they had been actually founded by the females in these situations. These two colonies were placed together in a plaster nest, but the larger one killed the queen and workers of the smaller and appropriated their brood. The nest is now in excellent condition, and has reared about a hundred workers during the two years, but no females have been produced, and only one male, on July 5th, 1911. The ants seem almost entirely carnivorous.

Workers of this species also have been often found in nests of other ants by DONISTHORPE.

The species of the genus *Cremastogaster* are undoubtedly self-founding. EMERY found a deälated female of *C. scutellaris* (in a hole in a tree) on October 11th, 1903. He placed her in a Janet nest, where she passed the winter without laying eggs. On April 16th, 1904, there were twelve eggs, but on May 2nd only ten.

On June 11th some of these eggs had become small larvæ; on the 21st two larvæ had pupated, and there were some eggs and one larva. Some of the eggs were used to feed the larva. The first worker hatched on July 9th; the second three days later, but was a cripple. He now gave the ants some honey, which was the first food they had taken. On August 6th there were six pupæ, one of which hatched on the 12th and another on the 14th. Thus the colony was definitely founded. POULTON and HAMM witnessed a marriage-flight of *C. scutellaris* (near Porto Pi, Palma, Majorca), in July 1901, and picked up three deälated females. These were kept by HAMM in Oxford in a small box without food or water. One of the females kept aloof from the other two, who were always seen together, and after a month or two the solitary female was found to have a leg missing, and shortly afterwards she was dead. The two survivors in due course laid eggs and brought up a small brood of larvæ, which produced small workers the following year, 1902.

Mr. COOK records a case of *C. lineolata* adopting a new queen.

He took a fertile female on April 16th, 1879, and on May 14th introduced her to workers of a colony taken the same day.

The workers displayed great excitement and clustered round the queen, who was immediately accepted, and was subsequently often seen attended in the galleries of the nest.

CRAWLEY found an incipient colony of *Aphænogaster fulva*, subsp. *aquia*, on September 18th, 1909, near Cleveland, Ohio. The nest was under a stone in a very dry, sandy locality, and contained a fertile queen and six or eight workers. Crawley took the queen and four workers, and brought them to England in October, where they were established in a Janet nest. The queen began to lay early in October, and the small bunch of eggs was invariably held in her mandibles or in those of a worker.

Honey, flies, and larvæ of other species were given the ants as food, but they never touched anything until May 29th, 1910, when the queen fed on a small fly. This was the first food eaten for over eight months. The first of the four workers died on December 12th, 1909, and the last on June 20th, 1910. The eggs did not hatch until June 24th, having remained unchanged for the unprecedented time of nearly nine months. The young larvæ grew rapidly, as they were regularly fed by the queen, who now readily devoured flies and other insects.

The first larva pupated on July 28th, 1910, and reached the perfect state on August 21st, when there were three pupæ. The queen assisted the young workers to get rid of their pupal skins. The remaining three pupæ hatched in due course, and by the end of September the colony consisted of four workers, the queen, larvæ, and eggs. While the number of the workers was so small, the queen herself continued to take in food and feed the larvæ, assisted in the latter operation only by the workers. The young workers were afraid to attack a still living fly, and used to seek the queen's assistance. On crossing antennæ with a worker alarmed by the presence of the fly, the queen opened her mandibles, went straight to the fly, and having dispatched it, left the task of cutting it up to her workers.

Later, when the number of workers was greater, the queen herself used to retire and allow the workers to kill the flies. The eggs laid by the queen in the summer and autumn of 1910 again passed the winter unchanged and hatched in the spring. By

the end of 1911 the workers numbered twenty, though there had been three deaths. At the moment of writing (end of July 1912) there are thirty-six workers and several pupæ, larvæ, and eggs. This small colony shows in a striking manner how faithfully a queen-ant will perform her task of rearing a family.

The length of the egg, larval, and pupal periods in this colony differs so widely from the observations of Miss FIELDE on *Aphano-gaster fulva* in its native country, that it is perhaps worth while to give the details. Miss FIELDE gives the duration of the egg period as 17 to 22 days, that of the larval period as 24 to 27 days, and the pupal as 13 to 22 days. The corresponding periods in CRAWLEY's colony were 250 days, 35 days, and 25 to 52 days. The difference of climate must have accounted for this great disparity.

WHEELER, in 1895, found thousands of isolated females of *Pogonomyrmex californicus* in the act of establishing their formicaries on the sandy bank of the Colorado River. The females burrowed down into the sand to the depth of three or four inches. He points out that, judging from the small number of adult colonies in the vicinity, very few of these females ever succeed in rearing a colony.

The females of our five British species of *Myrmica* are very little larger than the workers, and at first sight it might appear unlikely that they possessed the requisite amount of body fat to endure the starvation necessary during the process of rearing their first family. Yet it is undoubtedly a fact that they can, and do, found colonies, either singly or two or more together. The fact that there are generally at least three or four and sometimes a much larger number of queens in a single colony, points to the probability of several females joining together. Females after the marriage-flight may be received back into their own nest, but it is not probable that strange females are adopted, as these ants are very hostile to strangers, whether females or workers.

Lord AVEBURY first proved by experiment that *M. ruginodis* is self-founding. On August 14th, 1876, he isolated two pairs that he found flying, and placed them with damp earth, food, and water.

The females did not begin to lay until April 12th of the

following year. One of the males lived till April and the other till the middle of May. The first worker emerged on July 22nd, 1877.

Thus more than eleven months had elapsed between the fertilisation of the females and the appearance of the first workers, but it must be remembered that the females had been fed during this period. It is quite possible that this hardy female ant may, in nature, obtain food while bringing up her first brood.

FOREL, in June 1873, found an isolated fertile female of *M. scabrinodis* in a neat spherical cell of earth under a stone, with eggs and very small larvæ. At this time, FOREL, in accordance with the opinion of EBRARD, was inclined to doubt the capacity of isolated females to found colonies, as up to then no females had been found with large larvæ or pupæ, but only with eggs and small larvæ.

At Scarborough, in September 1893, CRAWLEY took a single deälated female of *M. ruginodis* after the marriage-flight, and put her in a small Lubbock nest. After a few weeks she made a small chamber, and enclosed herself completely inside it, but when two months had elapsed, she died without having laid any eggs. Again, on April 21st, 1896, he found a deälated female of *M. scabrinodis* wandering on a path near Oxford. As this species swarms in the late summer, this female must have spent the winter somewhere and have come out during the first warm days of spring to find a suitable spot for her nest. She built a small chamber in the earth in a Lubbock nest, and laid four eggs on April 25th, which she tended. Next day there were seven eggs, but a few days later she devoured two. By May 16th there were eighteen eggs, but from this date the nest was neglected, and the female died in June.

CRAWLEY has found colonies of *M. ruginodis*, *lævinodis*, and *scabrinodis* invariably hostile to strange fertile females of the same species, even in cases where the colonies possessed no queens of their own, and strange workers were always killed. In May 1909 he introduced a fertile *lævinodis* female to a strange nest of the same species, and she was at once dragged out and abandoned. On being put in a second time, she was again removed, and the workers attempted to sting her.

On the other hand, under certain conditions strange colonies

of *M. scabrinodis* will amalgamate. Two colonies were sent to DONISTHORPE from Miltown, co. Kerry, by BOUSKELL, in October 1911. He arranged them in a four-chambered Janet nest, so that each colony occupied two chambers at opposite ends, the passage connecting them being plugged with cotton-wool. One colony contained 5 females and workers, the other 2 females, workers and brood.

On January 12th, 1912, the cotton-wool barrier was removed, and the two nests allowed access to each other. No fighting was observed, but on March 2nd some females were dead. Later the remaining females and all the workers occupied the two dampest chambers in common, and at the present moment the two colonies are on perfectly good terms, and in fact have become one.

It may be observed in passing that *M. ruginodis*, *lævinodis*, and *scabrinodis* will readily accept pupæ of their own species from strange nests, and bring them to maturity, but *scabrinodis*, at any rate, will not rear pupæ of the other species.

Members of the genus *Myrmica* sometimes found branch nests similar to those of *Formica rufa* and *Lasius fuliginosus*. In April 1900 at Oddington, near Oxford, CRAWLEY noticed some workers of *Myrmica lævinodis* crossing a path in a shrubbery, carrying larvæ. The ants were traced, and found to be conveying larvæ from one nest in a rotten stump to another also in a stump. The first stump was nearly covered with moss, which would most likely account for the desertion. Further investigation showed that the colony, which was of enormous size for this species, occupied four nests, all but one of which were in rotten stumps, and workers were continually crossing from one to another. The space occupied by the nests was roughly 12 yds. by 6 yds. Workers from each nest were placed on the others, which they entered without molestation.

FOREL records the discovery of an isolated female of *Leptothorax tuberculatus* by KUBLI on December 14th, 1868, in an empty gall with three small larvæ. FOREL kept this female with her larvæ until August 4th following, when she died, the last larva having perished towards the end of April. CRAWLEY found an incipient colony of *L. tuberculatus*, subsp. *corticalis*, in a more advanced stage near Pangbourne, Berks, on April 24th, 1904.

This nest was inside an empty beech-nut, the entrance being a small round aperture, evidently the escape-hole of some insect. The nut contained a deälated female, one worker, and two half-grown larvæ, and was clearly a case of successful founding by a solitary female.

EMERY found that a female of *L. recedens* could bring up a colony in a month and a half. He took a deälated female at Bologna on July 2nd, 1904, and put her in a Fielde nest without food. On July 8th there were two eggs, on the 14th five; on the 21st a large larva, a small larva, and two eggs (thus some eggs had been devoured); on the 31st a pupa, a large and a small larva, and one egg. The first worker appeared on August 13th. He also took a flying female of *L. tuberum breviceps*, who kept her wings and yet laid eggs and brought up larvæ, one of which became a worker pupa.

L. acervorum is often found in the nests of other ants, and does not seem to be molested, and is indeed hardly noticed at all.

FARREN WHITE records it in a gorse stump in the centre of a nest of *F. sanguinea* at Shirley, and ROTHNEY (1882) continually found it with the same species in that locality. HAMM tells us he found it in a nest of *F. exsecta* at Bovey Tracey in Devon. POOL found winged males and females, as well as workers, in a *F. rufa* nest at Enfield (1906). DONISTHORPE has constantly found it with *F. rufa* at Weybridge, in 1902, and with *rufo* and *sanguinea* at Nethy Bridge and Woking respectively. He has found queens and workers of *L. nylanderi* with *L. fuliginosus* at Oxshott and elsewhere, and we have recently found in the New Forest many nests of *L. affino-tuberum* in close juxtaposition with nests of *Tetramorium cæspitum*. Colonies of each of the two latter species were placed by CRAWLEY in separate chambers of a Janet nest, and when the cotton-wool closing the gallery of communication was removed, there were at first a few skirmishes between the *Leptothorax* and *Tetramorium* workers. The *Tetramorium* then blocked the gallery with débris. We suggest that the *Leptothorax* find protection by nesting in or close to the nests of larger species, and their females after the marriage-flight may voluntarily seek the neighbourhood of larger ants to found their colonies. Thus DONISTHORPE found a deälated female of

L. acervorum in a nest of *F. pratensis* at Rannoch in June 1911, and CRAWLEY a deälated female of *L. affino-tubercum* in the earth of a nest of *Tetramorium cæspitum* in the New Forest in July 1912.

Our British species of *Leptothorax* are peaceable ants, and do not appear actively to resent the intrusion of strange ants of the same species. DONISTHORPE placed two colonies, each containing a queen and brood, from fir-stumps, some distance apart at Weybridge, into the same plaster nest, where they brought up their joint brood in perfect amity, and CRAWLEY, in July 1912, united two colonies of *L. affino-tubercum* from the New Forest, and found that they placed their brood in a single pile and mingled without any animosity. This being the case with *Leptothorax*, there is every reason to suppose that deälated females are received in strange nests after the marriage-flight.

The enormous females of *Tetramorium cæspitum* are certainly capable of founding colonies unaided. In July 1906 WASMANN found a number of deälated females of this species after the marriage-flight, near Luxembourg, some under stones in little cells. He took seven females and put them with damp earth in an observation nest, where they fought each other. On September 4th there was only one female surviving, enclosed in a cell with eggs and small larvæ.

The females of *T. guineense*, a species common in hot-houses throughout the world, are very little larger than the workers. Nothing appears to be known as to their habits of colony-founding. CRAWLEY observed a colony in a green-house at West Leake, Notts, during 1908 and 1909, and found that the queens came out of the nest and wandered about just like the workers, and we both found them doing a similar thing at Kew Gardens in 1910.

W. W. SMITH (1892) found incipient colonies of *T. nitidum* and *striatum* in New Zealand, under stones covering a network of vegetation, on which numbers of aphides and coccids were subsisting. These colonies ranged from a few ants of both male and female sex up to fair-sized nests containing workers. The ants were often seen carrying coccids about, and, from only finding nests under stones where there were coccids and aphides, SMITH suggested that the females, after the marriage-flight,

seek out such stones, in order to have a supply of food ready to hand while they are bringing up their young.

Among the Attii, the fungus-growing ants of tropical and sub-tropical America, we find the females very elaborately equipped for the purpose of rearing their families. The females are of enormous size compared with their workers, and are able to subsist for a long time without nourishment. As shown by VON IHERING, GÖLDI, SAMPAIO, and S. HUBER, the female on her marriage-flight carries away in her infra-buccal cavity a small pellet consisting of the hyphæ of the fungus which forms the sole food of the ants. This pellet is formed from the refuse of the ant's last meal, scraped from her mouth and body by her strigils. S. HUBER in 1905 traced the development of a colony of *A. sexdens* from the time a young female makes her cell in the earth up to the appearance of the first workers.

The female, after making her cell, expels the pellet from her infra-buccal cavity, and in a few days the hyphæ begin to sprout. She lays eggs a few days after her flight, and averages ten eggs daily. Most of the eggs are used by the ant for food, and not as manure for the small fungus-garden, as formerly supposed. The fungus is manured by means of the ant's own excrement. She breaks off a small piece of the fungus from time to time, holds it against the tip of her abdomen, drenches it with liquid excrement, and replaces it on the garden-patch. Thus the whole patch is gradually manured. The fungus itself is not used for food until the appearance of the workers, which takes place about six weeks from the time the female is established in her cell.

HUBER also states that fertile females of *A. sexdens* are readily adopted by strange workers of the same species. Such adoptions may partly account for the enormous size attained by some colonies.

Subfamily **Dolichoderinæ.**

EMERY, in 1904, exhibited at the International Congress of Zoology at Berne a nest of *Dolichoderus attelaboides* from Brazil. It was built of carton on a leaf and contained a single female.

Tapinoma.—We have been unable to find any direct evidence with regard to this genus. Judging from the size of the female, it is highly probable that they found in the normal way. The fact that so many queens are found in the same nest indicates the reception of females into the parent nest after the marriage-flight, or the joining together of several females to found their colony. DONISTHORPE has found several nests of *T. erraticum* containing two or more queens, and one this spring containing four queens, while CRAWLEY in 1905 found a colony containing six queens in Vaud, Switzerland, and in 1909 a large colony of *T. sessile* in Ohio, which contained more than thirty queens. In the New Forest on July 24th this year we found a nest of *T. erraticum* which contained some twenty queens.

Ants of this genus are very difficult to keep in captivity. They will feed on honey, small flies, etc., for a day or two, and then refuse all food. DONISTHORPE has had two colonies that devoured their own larvæ and pupæ, and the large colony of *T. sessile* mentioned above, which CRAWLEY brought to England, died off in two months. The ants in this case did not eat their brood, which was left to perish, but seemed to become gradually paralysed. DONISTHORPE has a nest, taken at Woking on May 12th, which contained many male and female pupæ, all of which were gradually devoured. The ants, however, have since brought up a number of workers, and the colony appears to be in good condition at present.

Subfamily **Camponotinae**.

ASSMUTH showed that *Prenolepis longicornis* in India (often common in hot-houses here and all over the world) sometimes founds its colonies by what has been called "secondary pleometrosis," *i.e.* by the females returning to their own nest after being fertilised in or near it. DONISTHORPE obtained thirteen females, in a flower-pot at Kew, with workers and larvæ, which is additional evidence of this habit, though there is no reason to suppose that the females cannot found colonies singly.

Coming to the genus **Lasius**, we find conclusive evidence of both normal founding and "temporary social parasitism." We are for the moment concerned only with the former.

The fact that the large-bodied females of this genus, viz. *flavus*, *niger*, *alienus*, and *emarginatus*, lay eggs only a few days after fecundation, whereas the temporary social ones, *umbratus*, *mixtus*, and *fuliginosus*, do not lay till the next year, is *a priori* evidence that the former are self-founding.

L. flavus.—This ant, the most abundant species in this country (single fields sometimes containing hundreds of its grass-covered mounds) is a good example of the normal method, its females, many times larger than the workers and males, being abundantly endowed with the necessary reserve force for a protracted fast. Ordinarily the fertilised female brings up her brood alone, but, as we shall see presently, two or more may do so jointly.

ERNST showed that this species is self-founding. In October 1902 he found at Le Chenois a deälated female under a stone where she had constructed a small cell. No eggs were laid till April 22nd (it is very probable there had been eggs when the ant was found, since, as we have before stated, females of this species lay eggs a few days after fertilisation), and larvæ were found on August 22nd and pupæ on October 3rd. It was not until November 9th that a pupa hatched, eleven months after the finding of the queen, but the colony had laboured under difficulties from the commencement, since ERNST did not understand the treatment of ants in captivity.

CRAWLEY in August 1897 found a single deälated female in a small cell under a stone, without brood, at Oddington near Oxford.

There may be more than one queen in a *flavus* colony. We have several times found two queens in a single nest. A case of this description may be due to one of two causes—either the founding of the colony by two females in common, or to the acceptance of an additional queen from their own or a strange colony. There is a good deal of evidence in support of both hypotheses.

FOREL, about 1873, found under a stone at Salève a neat cell occupied by two fertile *flavus* females without brood.

CRAWLEY on August 6th, 1904, found four females together under a stone at Oddington, but as there was no brood and no enclosed cell it was probably only a temporary retreat immediately after the marriage-flight and shedding of wings.

HAMM dug up no less than sixteen deälated females of *flavus*, with about twelve small workers, in the New Forest on April 16th, 1911. These females and workers were kept in captivity, and though through neglect the workers died, the females have now reared a quantity of larvæ, which they tend and sort into groups corresponding to their size, just as the workers of this species do. No hostility has at any time been observed among the females.

On June 6th, 1907, Wheeler found two deälated females near Sion in the valley of the Rhône, in a small earthen cavity under a stone, with a single packet of eggs and young larvæ. He had already found, in August 1904, a colony consisting of two deälated queens of *L. brevicornis* with a few larvæ, cocoons, and two callow workers. They were observed to assist callows from their cocoons.

WASMANN made a discovery in 1909 which indicates that, though many females of *flavus* may start a colony together, they eventually split up into groups of not more than two. Certainly we know of no case where more than two females have been found in one nest. He found under a stone in a small cell, at Luxemburg in September, four females with eggs and a dead mutilated body of a fifth. After the first larvæ had hatched the females split into two groups of two each. This species is much less pugnacious than *niger*, and probably fighting among the females is of much rarer occurrence.

All the above are probably cases of females flying from the same nest and meeting later by accident, as *flavus*, though not so hostile to ants from strange colonies as *niger*, yet objects to their presence and drives them from its nests.

On rare occasions workers of *flavus* may accept a strange queen; or one of their own females, after fecundation; thus on August 1st, 1896, CRAWLEY took a deälated female after the marriage-flight and placed her with twenty workers from her own nest. On the third she began to lay, and in due course a flourishing colony resulted.

Again, at the end of July 1897 he had a queenless colony of *flavus* in a Lubbock nest. A strange fertile female was then taken and put in a box with four workers from this nest. As they seemed friendly the box was turned on its side close to the

door of the nest. Presently the workers entered the nest, and the female of her own accord followed them. Ants saluted her, and only two attacked her for a short time, and finally she was accepted as queen. Shortly after this the workers killed all the ten winged females that were in the nest, a proceeding that we have noticed several times with this ant, *niger*, and others under similar circumstances.

In 1899 CRAWLEY took three fertilised females after the marriage-flight and put them in a nest with pupæ and one hundred strange workers on August 15th. All were friendly, and by the 21st all three females had laid eggs. One of the females died, and her decapitated body was found outside the nest. No attacking had been noticed, and the colony existed for some time with the two remaining queens.

On the other hand, instances of colonies, both with and without queens of their own, refusing strange queens are more numerous. LUBBOCK records five failures of this kind, and CRAWLEY two in 1893 and 1910, and had others not recorded.

L. niger.—The females of *L. niger*, *alienus*, and *emarginatus* are even better adapted for founding their own colonies than those of *flavus*, inasmuch as they are larger in proportion to their males and workers. A great many colonies have been brought up in captivity by females, and several observed in nature.

In August 1873 FOREL received a piece of marl containing a fertile female of *niger* alone in a cell with a small batch of eggs.

FARREN WHITE records finding at Lulworth in 1881 a single deälated female of *alienus* with three or four pupæ.

At Wellington College in April 1903 CRAWLEY turned up a solitary *niger* female in a heap of sand. Under these circumstances it was not possible to see whether the female was in an enclosed cell. No eggs or larvæ were found.

Again, in September 1904, JANET found under a small stone a deälated female *niger* alone in a cell with a small batch of eggs. When placed in a plaster nest, she showed her capability to work, by building up a barrier with fragments of cork at each end of a gallery between two chambers. In this case the first workers did not emerge till the following spring.

At Ouchy, Switzerland, on June 3rd, 1905, CRAWLEY found

two incipient colonies in cells under stones, one a *niger* female with a few larvæ and some very small neuters, and the other an *emarginatus* female, with larvæ. The latter was taken and installed in a Lubbock nest. The first larva pupated on June 21st, and on July 12th the first pupa hatched, the female assisting the callow to remove its pupal skin. Another emerged the next day, and others followed in due course. This colony was brought to England, where it flourished till the summer of 1907, when the ants were killed, owing to the nest having been left in the sun too long. The *emarginatus* workers readily accepted English *niger* pupæ, and at the time of its destruction the colony consisted of about equal numbers of *emarginatus* and *niger* workers.

Nests of *niger* will receive and hatch both worker and female pupæ of *L. alienus* and vice versa, larvæ even being accepted in some instances.

On October 28th, 1908, DONISTHORPE found numerous isolated females of *niger*, in cells under stones, and in crevices, at Luccombe Chine, Isle of Wight. In one instance two females were in the same cell with a batch of eggs. When recording the latter case, he called attention to Wheeler's discovery of two *brevicornis* females mentioned above. As we shall presently see, it is not an uncommon thing for two or more *niger* females to combine in starting a colony.

Turning to cases of females taken without brood bringing up their families in captivity, we find JANET in April 1893 isolated an old queen from a nest of *alienus*. This queen, who was supplied with food (since she was past the age when a female can subsist on her body-fat and wing-muscles, as JANET showed), laid eggs soon after her isolation, and reared twelve larvæ and a pupa in sixty-one days, and five pupæ and one worker in 102 days. The same writer mentions that females of *niger*, taken after the marriage-flight in August 1904 and kept in captivity, brought up workers by the first days of October.

VON BUTTEL-REEPEN took two deälated *niger* females after the marriage-flight on July 22nd, 1903, and placed them in a glass nest with earth, in which they dug two separate holes and laid eggs by the middle of August. About August 20th one female broke into the cell of the other, brought her eggs, and settled with her. The two females henceforward lived together

and heaped their eggs in one bunch. The first larva appeared one month after the eggs were laid, twenty-four in all hatching. After eight months some larvæ pupated, and the first worker appeared about a year after the females were fertilised. After five workers had hatched, the females ceased to look after the brood. On August 5th the two females commenced to fight, the workers attacking the female that was getting the worst of the combat. This female died the next day, leaving the colony with a single queen.

SOUTHCORBE took some newly-fertilised females of *L. niger* in July 1905, and offered some to wild nests, and others to a captive queenless colony. In every case the females were torn to pieces, the queenless nest in particular showing great ferocity towards the strange females. (This is important in connection with the acceptance of females of *L. umbratus* by *L. niger* queenless colonies, as will be seen later.)

Others, placed in boxes, burrowed into damp earth, but by next spring only two remained. SOUTHCORBE suggests that the others had been killed. On September 11th there were two workers.

Though ignorant of these experiments, CRAWLEY was led to the same conclusion, viz. that sister females of *niger*, who have combined to bring up their family, end by fighting till only one remains, by a series of observations extending over some years. It is a remarkable fact that colonies of this ant are very rarely found with more than one queen; indeed it is not often that one succeeds in finding even a single queen. DONISTHORPE has never found two queens in one nest, and CRAWLEY has only once done so, in August 1895, when part of a *niger* nest was taken one day with one queen and the remainder on the next with the other queen. The new workers and the second female were received amicably, but later in the day the second female was dragged out of the nest and left in the corner of the box. She was not attacked or harmed in any way. Colonies of this species were always found very hostile to strange fertile females, whether the colonies possessed queens of their own or not. On July 20th, 1911, having picked up some deälated females after a marriage-flight at Sea View, Isle of Wight, CRAWLEY placed three in a small box together. They jointly excavated a cell

in the earth and built up a roof covering them completely in. Ten days later the cell was opened and found to contain a quantity of eggs.

One of the females was then placed with four workers from a queenless colony, but she killed them all. Another female was then placed in the light chamber of the queenless nest, and in a few minutes was found on her back attacked by a score of workers, and so was removed. The three females were then re-united and placed in a four-chambered plaster nest with a large number of pupæ and a few callows. One female immediately began to carry the pupæ into a dark chamber, and though assisted for a short time by another female, carried over one hundred pupæ herself. Several mature workers, hatched from the same lot of pupæ, were put in the nest, but they were killed at once by the females, who had not, however, molested the callows. Next day each female occupied a chamber to herself with pupæ, the energetic female, distinguished as A, having by far the largest number. On August 2nd one of the other two females was dead, and in A's chamber. At this time about 150 workers had emerged, and the females had laid eggs and ceased to work. On August 4th some workers began to attack the other female, and though a few saluted and caressed her, she was killed. Thus the female A was left as the sole queen of the colony.

Again, on July 22nd, at Sea View, CRAWLEY took three deälated females of *niger* and placed them together in a box with damp earth and no food. On the 24th they laid eggs, and next day one excavated a cell by herself and covered herself in. The other two remained outside with their eggs. A week later these two had also disappeared under the earth and left no trace.

On August 23rd the cell excavated by the first female was carefully opened, and found to contain all three females, thin but active, with a quantity of very small pupæ, some larvæ, and eggs. The breach in the roof of the cell was quickly repaired by the females, and the box was left untouched until September 9th. The cell was then seen to contain, besides the three females, pupæ, and larvæ, two very small mature workers and twelve callow workers. This was forty-eight days since the first eggs

were laid. The ants and brood were then transferred to a two-chambered plaster nest and given honey, which the workers and females drank. This was, of course, the first food the females had taken since their flight.

On September 10th the brood had been removed to one corner of the chamber occupied by all the ants, and one female, A, with several workers, was standing over it. At the other end of the chamber the two other females, B and C, were engaged in a furious combat. While they were being observed with a lens, C received a drop of formic acid and immediately collapsed. The whole of the time they were observed to fight, workers were attacking both, and judging from the final result, it would seem that the workers had the instinct to perceive which of the three was the fittest, viz. A, and were attacking the other two, as they had done in the previous experiment. The victorious female, B, after the collapse of her rival, became greatly excited, and kept making journeys to the other end of the chamber, touching A with her antennæ, and then returning to bite the moribund female C. The workers meanwhile were occupied in dragging about the body of C, and attacking B. Later, however, a worker was seen to feed B. One hesitates to suggest that this friendly worker was one of her own offspring. Throughout all this tumult A remained motionless on the brood and assisted a callow to emerge. B several times during the evening crossed antennæ with A, and the last observation that night showed both females together and apparently on good terms. Next day at 11.30 a.m. they still seemed friendly, though B was agitated, and A quiet as before. In the afternoon B was attacked by some workers, and again in the evening by eight, who almost succeeded in pinioning her. She endeavoured to conciliate them by stroking them with her antennæ.

Finally, at 6.19 p.m., A left her corner, met B, and began to fight with her. B attempted to poison A, but both rolled over and separated, A having one fore-leg damaged. B was then pinioned by workers, and two others attacked A, for the first time. At 6.48 p.m. A went up to B, who was now free of workers, seized her by an antenna, and then by a leg: the two ants rolled over and struggled for some time, until A disengaged herself and retired to her corner, leaving B dying.

Three times after this A came up to B and bit her, and on the third occasion succeeded in poisoning her. Next day B was dead, and the workers removed her body and that of C into the next chamber. It is noteworthy that neither of the females who were attacked made any attempt to escape into the adjacent chamber, which they might easily have done. This incipient colony is at the time of writing in a flourishing condition, with over a hundred workers and larvæ and eggs.

Five deälated females, of *niger* were also picked up in the Isle of Wight in 1911, and brought up a few workers by the winter. Three females died owing to the presence of mould, but the survivors have now reared over a dozen workers, and so far are friendly. The workers broke open the earth cell in July.

MRÁZEK's experiment, though not conclusive, as the females were not actually observed to fight, points to the murder of one female by another. In March 1904 he found two deälated *niger* females in a closed cell under a stone. He put them in a small plaster nest with honey, which they drank. On April 11th eggs were laid, and by the beginning of June there were pupæ, which started to hatch at the end of July. When there were about thirty workers the females no longer attended to the brood. On returning after an absence from home, he found one female dead and cut in pieces. In this and similar cases where females are found in the autumn and spring without brood, it seems clear that the conditions have been adverse and the females have been compelled to devour all their eggs. Under these circumstances it is perhaps unlikely that in nature the females would succeed in rearing a colony.

The remaining species of our British *Lasius* will be dealt with under " Abnormal Methods " (p. 47).

Genus **Formica.**

F. fusca and its races undoubtedly found their colonies alone. WASMANN in July 1906 discovered at Luxemburg two incipient *fusca* colonies, one with a queen and six workers, and the other with two queens and six workers, and also a young colony of *rufibarbis* consisting of a queen with fifty newly-hatched workers.

We found in the New Forest this July an incipient colony of *glebaria* with one female and about twenty workers.

EMERY isolated a *glebaria* female without food on June 25th, 1909, and by August 12th four very small workers reached maturity. Two of the larvæ had been used as food. All the workers that hatched during the year were as small as the first four workers.

On September 14th, 1910, DONISTHORPE took five *fusca* females from a colony under the bark of a tree-stump at Balrath, Co. Meath. This colony contained very many females. On September 17th he placed them all together in a plaster nest, where they all laid eggs, which they carried about. These eggs afterwards disappeared. Three of the females were taken away for other experiments, and the remaining two lived together all through 1911. On January 31st, 1912, one of them laid a few eggs, which she held in her mandibles. On February 6th, both females were holding bunches of eggs: they were quite friendly, and sometimes one alone carried all the eggs. Eight larvæ were present on February 27th, three of which pupated on March 2nd. This number increased to seven by the 11th. A fresh batch of eggs was laid on March 24th. On April 1st the first *fusca* callow hatched and was carried about by one of the *fusca* females. A second appeared on the 3rd. On the 4th another callow hatched, but was dead, and on the 8th a third, which was assisted by one of the two others. Some more eggs were laid on the 7th and were carried about by one of the workers. A fourth callow was present on May 19th. On May 14th there was a small bunch of larvæ carried by the callows. By June 6th one of the females had a swollen abdomen, but the other, which had been ailing for some time and was of normal size, was dragged by an antenna by one of the workers. Since ants do not drag each other by the antennæ when their motives are friendly, this would seem to be a hostile act: at any rate this female was dead on June 7th, and put in the outside chamber. The female with the swollen abdomen and all four workers are alive and well to-day. This is the first time that an incipient colony of *F. fusca* has been reared by isolated females in captivity.

SCHIMMER in 1908 found a colony of *fusca*, v. *fusco-rufibarbis*, consisting of fifteen females with only twenty to thirty workers.

He concluded that it was formed by the adoption of females from strange colonies, as the colour and markings of the females were very different, many belonging to the brightly coloured subspecies *rufibarbis*.

KEYS found that females and workers of *fusco-rufibarbis* from different colonies in the same locality (Whitsand Bay, Cornwall) agreed perfectly well together. This points to the "recognition method" being inherited in a common stock. Under *F. rufa* will be found experiments which point to a similar conclusion.

DONISTHORPE in April 1907 found that a female of *fusca* from Bradgate Park was accepted by some workers of *fusco-rufibarbis* from Whitsand Bay, and also that several different lots of workers of *fusco-rufibarbis* from Whitsand Bay in 1909 voluntarily mingled and formed a single colony. CRAWLEY, on October 7th, 1909, introduced a worker of *F. subsericea* from the United States to a female and worker of *F. fusca* from England. The *subsericea* killed the worker, but was friendly with the female. Three days later thirteen more *subsericea* workers were introduced, and all were friendly with the queen. This colony is still in existence this year, and a few *subsericea* workers still remain, though there is a large number of *fusca* workers reared from eggs laid by the queen.

On the other hand the acceptance of strange females by *fusca* nests, and its races, possessing females is far from being the general rule.

Some years ago CRAWLEY made several experiments with *fusca* queens and colonies of *fusca*, both with and without queens, in all of which the strange females were attacked. In April 1909 he introduced a queen of *fusca* from Wellington College to some workers of *glebaria* from the New Forest, when the female was at once attacked. Three days later the same queen was placed in a nest of *fusca* containing workers, and she was again attacked, though the nest came from the same locality as the female. Again, on May 22nd he put the same queen into another small nest of *fusca* with a queen, also from Wellington College, and she was killed. On July 15th, 1911, he put a young deälated female of *fusca* from Devon into a nest of *fusca* from another part of the county, which contained a female.

She was violently attacked and was found dead next day. It seems unlikely that in nature a colony of *fusca*, or its races, would be founded in any other way than by the normal, viz. by one or more queens without workers.

Genus **Camponotus**.

A great many incipient colonies of species of *Camponotus* have been observed and described. McCook in 1883 published an account by E. POTTS showing how females of the "Carpenter Ant," *C. pennsylvanicus*, can found colonies by themselves. WHEELER says that in many localities in the northern States it is hardly possible to tear a strip of bark from an old log without finding one or more females of *C. pennsylvanicus*, or some of its allied varieties, each in her little cell brooding over a few eggs, larvæ, cocoons, or minim workers. They often take possession of the deserted pupal cavities of a longicorn beetle. These cavities are surrounded by a regular wall of wood-fibres arranged like the twigs of a bird's nest.

BLOCKMANN, in 1885, took a number of females of *C. ligniperdus* near Heidelberg, and placed them in separate nests. After an absence of three months he found there were workers in all the nests. He mentions five different stages he found incipient colonies in, in nature, from a female alone to a female with eggs, larvæ, pupæ, and one or two workers. He also gives a list of solitary females that he says he had found alone with eggs, viz. *F. fusca*, *sanguinea*, *L. niger* and *umbratus*. Of these *sanguinea* and *umbratus* appear to us to be very doubtful, and WHEELER describes the former as "a possibly inaccurate and certainly inadequate recorded observation."

FOREL, who at the time of the appearance of his book on the ants of Switzerland, was sceptical as to the power of females to bring up colonies unaided, himself eventually kept a female of *C. ligniperdus* until there were eggs, larvæ, and pupæ. He received from EMERY in August 1901 a fertile female, which had been found by the latter in a closed cell with a bunch of eggs. FOREL placed this female in a small nest with moist earth, but no food. He noticed some eggs on February 2nd, 1902, but could not be sure whether they were new ones, or

those that had come with the ant. Later there was one pupa, and by the end of the month three were present. Finally two workers reached maturity, but the female ceased to look after her offspring, and the incipient colony perished. He suggests three means by which the female was kept alive and fed the larvæ: (1) by the secretions of her own body, (2) by devouring some of her eggs, (3) by drinking the water in the moist earth, which might contain in solution some nutritive substances.

CRAWLEY kept for some years a female of *C. ligniperdus* which brought up workers, though she was assisted by workers to a certain extent. The female was found deälated after the marriage-flight at Ouchy, Switzerland, on June 15th, 1905. She was first placed in a box with three workers from a nest near by. The workers were not hostile, but seemed alarmed and avoided the female. Three others from another nest were then tried; they attacked her, and so were removed. This seems to show that the adoption of a strange queen is unlikely. She was then placed in a Lubbock nest with a few half-grown larvæ from the nest of the hostile workers, which she fed until they pupated, at the end of June. The first worker emerged on July 28th, in England; she laid eggs and brought up a fair number of workers during 1906 and 1907. The nest contained twenty to thirty workers when it was eventually killed by the rays of the sun in the summer of 1907.

An experiment by SCHMITZ, in 1911, shows that females of *C. ligniperdus* that have founded a colony together end by fighting until only one female remains. This, as with *L. niger*, only takes place when a fair number of workers have been reared. He found at Schönaus in Taunus, during July and August, seven young *Camponotus* colonies, ranging from a solitary female in a hole, without any young, through all stages up to a female and a dozen workers with brood. Two of these incipient colonies were under the same stone, though in separate chambers, and this suggested to him the possibility of two or more females joining forces to bring up their families. Accordingly he took the two females and a few larvæ, and put them in a glass nest on July 25th. They were perfectly friendly, and laid eggs. On August 1st ten workers appeared. Two days later, when there were about twenty workers, the two females fought fiercely,

the workers remaining neutral. Next day the colony split into two camps, each containing one female and workers, first one female and then the other gaining possession of the brood. From time to time the females fought. This he says proves that two females may sometimes found colonies together, but eventually part and form two separate ones. The workers did not favour either female, as they do in the case of *L. niger*, and though one female lost an antenna in the fighting, neither was killed, the females separating. In the case of *L. niger* it will be remembered the antagonists had no thought of escaping, though they might readily have done so.

ABNORMAL METHODS.

We now turn to those species of ants whose females have lost the instinct and have no longer the power to found colonies by themselves. It is now a well-established fact that, as ADLERZ suggested years ago, those females which enclose themselves in a cell completely shut in until they have brought their offspring to maturity, take no food whatever beyond that supplied by their own bodies during this period, which may extend for a few weeks to many months. The larvæ are fed by the females with secretions arising from their store of body-fat and the degenerated wing-muscles, and occasionally from their own eggs.

Now in several genera some species are found whose females in comparison with their workers are much smaller than those of the other species which are known to found their colonies unaided. It is improbable that they should be able to endure the strain of starvation and the rearing of the larvæ with such scanty resources. Mere smallness of stature, however, must not be taken as evidence that a female cannot rear workers herself, for we have seen that the females of several of our species of *Myrmica* and *Leptothorax*, which are only slightly larger than the workers, can successfully found colonies.

The fact that no one has ever found an isolated female of the various species of the *Formica rufa* and *F. exsecta* groups in the act of bringing up her brood, coupled with the small size of some of their females as compared with the workers, led several

myrmecologists, in particular WHEELER and WASMANN, to investigate the matter with great care. The result of their observations and experiments leaves no doubt that females of these ants are unable to found colonies alone.

Colonies of *F. rufa*, and probably other species, often contain a large number of queens. For instance, in a single nest at Porlock, which we dug up in April 1911, were considerably over one hundred queens, and as we only investigated part of the nest, the number must have been much greater. Other nests in the same locality, and at Weybridge and elsewhere, contained a similar number of females, and though an occasional nest may be found in which it is difficult to detect a queen, the general rule is for nests of this species to contain a good many. WASMANN has likewise recorded the presence of more than sixty queens in nests of *F. rufa* at Limburg. This condition is evidently brought about by the readmission of deälated females after the marriage-flight into the parent colony.

Colonies which keep up their supplies of queens in this way may last for very long periods. A large nest of *pratensis* has been observed by FOREL for over fifty years, DONISTHORPE has known a nest of *F. rufa* at Weybridge for twenty years, and there is the case of a nest of the same species that DARWIN's informant, a man of eighty, had remembered as a boy.

Since a colony may consist of several nests, each containing queens, and some eventually becoming separate colonies, though not hostile to the parent one, fertile females from one nest may readily be received into another some distance away.

CRAWLEY, in 1904, took queens from nests in a valley at Porlock where there were a large number of colonies, and found them accepted in other nests there. This we think points to a common origin of all the nests in a locality, since we have found that queens of *F. rufa* from distant parts of the country were always killed by the strange colonies to which they were introduced. However, as WASMANN found seven queens in a nest of *pratensis*, one of which was a *rufa* and another a *truncicolo-pratensis*, the remaining five being pure *pratensis*, these nearly allied races may sometimes accept queens from each other's nests.

Colonies often arise by the building of a branch nest, as

WASMANN has shown, some distance from the parent colony, and the gradual emigration of a large body of workers, with queens and brood, to the new site.

DONISTHORPE observed a branch nest of *Formica rufa* in the Black Wood at Rannock on June 12th, 1911. Two nests were found to be in connection, 128 yd. apart—one a large mound about 72 in. across by 54 in. in height, a few yards below the path, and the other a small hillock about the same distance from the path on the other side of it. The ants were going backwards and forwards along the path to the two nests. Food was being carried to the larger nest, but the ants were carrying their larvæ from the large nest to the smaller one. A deâlated female was trying to get to the smaller nest; though often stopped by the workers she persisted, and gradually won her way to it. Winged females were upon the larger nest. Thus a single colony may in time spread its branches over a very large area. This has probably been the means, as suggested by WHEELER, of depriving queens of the *rufa* group of their primitive ability to establish exclusively through their own initiative.

Some writers (LEPELETIER DE ST. FARGEAU, SILVERLOCK, etc.) have suggested that young fertilised females, after the marriage-flight, meet a few stray workers and then start a colony with them. We may at once say that, judging from over twenty years' experience of the behaviour of ants under various conditions, this is highly improbable. If a few stray workers met a fertile female from the same colony, or from one originally sprung from the same stock, they would undoubtedly convey her to their nest, so strong is the desire of workers to return to their own home. If a female met workers from a strange colony, she would avoid them, or they would certainly attack her. When a few workers of *F. rufa* in particular are isolated, whether with a queen or not, they lose all interest in their surroundings and seem to pine away.

A colony of *F. rufa*, kept by CRAWLEY on the same table with another strange colony, voluntarily quitted its own nest and allied itself with the latter. The former colony came from Weybridge in 1912 and consisted of a hundred or so workers, with eight queens and brood, and the latter was taken at Porlock in 1911 and contained six queens and more workers than the

other. Soon after its establishment workers of the Weybridge colony were seen at the door of the Porlock nest, and on April 2nd, 1912, the Weybridge workers were found busily transporting their own females, workers, and brood to the Porlock nest, where they were received without hostility. Next day the two colonies were amalgamated, but though there were no fights between the workers, three females were eventually killed. Thus queens from both colonies were killed, but not a single worker. This suggests that it is possible for a large colony of this species completely to absorb a smaller and weaker one.

There is, however, another way in which colonies of *F. rufa* and *F. exsecta* groups are founded, and that is by what is now known as "Temporary Social Parasitism." The female seeks out a colony, generally queenless, of *F. fusca* and its races, and is adopted by the workers, who bring up her brood. The colony eventually becomes a pure one of the female's species, owing to the natural death, in due course, of the host workers. To Professor WHEELER is due the credit of this discovery, which he has confirmed by many experiments. The number, however, of such incipient mixed colonies that have actually been found in nature is very small. In July 1871 FOREL found, near to Loco (Tessin), under a stone, a colony consisting of three-quarters *fusca* workers and one-quarter *truncicola* workers, with larvæ and cocoons of the latter. Apparently he did not see the queen, which would have run underground. About the same time he found a small nest of *exsecto-pressilabris* containing a certain number of *fusca* workers. In both these cases there was the utmost friendliness between the two species. Again in August of the same year he found a mixed colony of *pratensis* and *fusca* with a number of small cocoons in the nest. WASMANN found an incipient colony of the same two species in Holland.

That these mixed colonies represented a regular mode of colony-founding was, however, unsuspected until WHEELER, closely followed by WASMANN, formulated his theory of Temporary Social Parasitism in 1904. He found many mixed colonies consisting of females of the North American *F. consocians* and workers of the timid *F. incerta*, and concluded that a young fertilised female of the former entered small incipient or depauperated colonies of the latter, induced the workers to accept her, and to

bring up her brood. In only one case did he find an *incerta* female present. In course of time the nest assumes the form of a *consocians* nest, and eventually becomes entirely such.

His experiments with these two species demonstrated several surprising facts :

1. A *consocians* female that has been living with *incerta* workers is readily accepted by strange *incerta* workers.
2. If a *consocians* female has been living with her own species, she is not accepted unless very young.
3. A *consocians* female that has been living with *incerta* workers is violently attacked by a colony of her own species.
4. An *incerta* colony is far less hospitable to strange *incerta* females than to *consocians* females that have been living with strange *incerta* workers.

Other instances that WHEELER found in North America are *F. microgyna* (he found three mixed colonies of *F. microgyna*, v. *rasilis*, and *F. fusca*, v. *argentata*) and *F. dakotensis* which he found in association with *F. incerta* in Colorado. MUCKERMANN found mixed colonies of *F. dakotensis*, v. *wasmanni*, and *F. subsericea*.

WHEELER suggested that a similar condition would be found to obtain with *F. rufa* and *exsecta* and *F. fusca* in Europe. This would, of course, explain the mixed colonies above mentioned found by FOREL. The female of *F. rufa* is, however, much larger in proportion to its workers than those of the American ants just mentioned, but though fresh colonies are most often formed by branches from the parent colony, we shall see that both *F. rufa* and *F. exsecta* occasionally succeed in bringing up their families with the aid of *F. fusca*.

The case of *F. truncicola*, a continental subspecies, is already clear. Three mixed colonies with *F. fusca* have been found by WASMANN, two in Luxemburg and one in Saxony, in addition to the one found by FOREL. WASMANN, on March 22nd, 1908, found at Luxemburg a young *truncicola* colony in a pure *fusca* type of nest, where there was no *fusca* present. On April 15th they had moved and built a true *truncicola* nest. He states that a *truncicola* female regularly grounds her new colony, with the help of *fusca*, after the marriage-flight, by entering a *fusca* nest.

In May 1902 WASMANN discovered a *rufa* female under a stone over a *fusca* nest, but separated by a partition of earth, at Luxemburg. The female was evidently awaiting her opportunity to enter the nest. In February 1906 he found two nests of *fusca* at Luxemburg, containing a *rufa* female; in April, in company with SCHMITZ, a small mixed colony of *rufa* and *fusca*, containing a *rufa* female only; and in May of the same year they found another in a less advanced stage, a *rufa* female with eggs and one hundred workers being present. WHEELER in 1908 and 1909 records finding three mixed colonies of *F. rufa* and *F. fusca*. One below the Turtmann Glacier was a large nest of *F. fusca* and larvæ and a single *rufa* female. Another smaller one contained, in addition to one live *rufa* female, four dead ones, cut in two. Evidently five had entered the nest, but only one had been successful. The third was more advanced, containing twelve *fusca* workers, and twenty-four *rufa* workers.

DONISTHORPE, in 1909, actually observed a *rufa* female making her way into a *fusca* nest. He was in Parkhurst Forest, Isle of Wight, with Taylor, on May 15th, when many females of *F. rufa* were seen, some with wings and others deälated. One of the latter was noticed near the entrance of a *F. fusca* nest, accosting the workers, and endeavouring to enter their nest. She had several fights with some, rolling over and over on the ground. She eventually beat off the workers and finally entered one of the doors of the nest, and was lost to view. On August 21st DONISTHORPE and TAYLOR were again in Parkhurst Forest, and having found a very small nest of *F. rufa*, which was undoubtedly a new one, it was decided to dig it up. The nest was only about 8 in. in diameter by 3 in. in height and 6 in. deep, but built of the usual materials. It contained 150 *rufa* workers, most of them very small, one *rufa* female, about eighty *fusca* workers, and a number of cocoons. The cocoons hatched later and proved to be *rufa* workers.

On June 10th, 1911, in the Black Wood, at Rannoch, DONISTHORPE found a dead deälated *rufa* female in a *fusca* nest under a stone. It had evidently entered the nest and had been killed by the *fusca* workers. On June 14th, in the same locality, high up on the mountain where no *rufa* nests occur, he observed a deälated *rufa* female walking round a stone over a *fusca* nest.

She eventually got under the stone and entered the nest, which contained a small *fusca* colony. Owing to lack of time, further investigations were impossible.

The females of *F. exsecta* are smaller in comparison to their workers than those of *F. rufa*. They are darker and more like *fusca* females in general appearance, and WASMANN states they are more readily accepted. Mixed colonies of *F. exsecta* and *F. fusca* have been found on various occasions.

In September 1867, near Apples, FOREL found a very small mixed colony which contained typical *fusca* workers and very small workers of *F. exsecto-rubens*. In April 1870 BUGNION gave to FOREL typical workers of *F. fusca* and *F. exsecta* which he had taken in a mixed colony under the bark of a tree near Lausanne, and in the following summer BUGNION found a mixed colony of *F. exsecto-pressilabris* and *F. fusca* under a stone at Ormonts.

In October 1906 WASMANN found, at Luxemburg, an *F. exsecta-fusca* colony in a simple earth-nest of the *F. fusca* type, containing an *F. exsecta* female, several hundred *F. exsecta* and *F. fusca* workers and pupæ of the former. No queen of *F. fusca* was present in the nest. In 1909 he records that he found three mixed colonies of these two species in the same locality.

The *F. exsecta* nests found by DONISTHORPE in the Isle of Wight and one part of Aviemore in Scotland, bore resemblance to the ordinary earth type of *F. fusca* nests, and had probably originated in *F. fusca* nests; but those at Bournemouth, where many nests were found together, were built in the usual *F. exsecta* manner with ling and grass, and probably owed their origin to branch nests, from a parent colony. Cases in point are the enormous colony of *F. exsecta* recorded by FOREL in a clearing in the Forests of Mont Tendre, which consisted of over 200 nests which occupied a radius of over 150 metres. Millions of ants circulated in every direction from one to the other; and a similar colony of *F. pressilabris* was found near Geneva.

On May 27th, 1910, DONISTHORPE found a nest of *F. exsecta*, near Bournemouth, at some distance from the nests before mentioned from that locality. It was of the usual *F. exsecta* type, but quite small. On being examined it proved to contain both *F. exsecta* and *F. fusca* workers, the workers of the latter

being in considerably greater numbers. Here undoubtedly was a new *F. exsecta* colony, founded by a young queen of that ant, which had entered a *F. fusca* nest, and been accepted by them. HAMM tells us he found a mixed colony of *F. exsecta* and *F. fusca* on August 26th, 1911, at Bovey Tracey, Devon.

In North America mixed colonies of *F. exsectoides*, corresponding to our *F. exsecta*, but with larger females, and *F. subsericea*, very similar to our *F. fusca*, have been found by FOREL at Hartford, Conn., and by SCHMITZ, who found five near Beatty, Pa. All were small colonies, none containing more than fifty workers of each species, and a female of *F. exsectoides* was always present. WHEELER has also found similar colonies, and he states the queen is very passive and conciliatory and is readily adopted by the host workers.

This list of natural mixed colonies leaves no doubt that ants of both the *F. rufa* and *F. exsecta* groups are Temporary Social Parasites on *F. fusca* and its races, but numerous experiments have been carried out by WHEELER, WASMANN, VIEHMEYER and others with generally successful results. The females usually employ conciliatory methods to secure adoption, but where they meet with stubborn resistance, they resort to force to secure their ends. Thus VIEHMEYER had a *truncicola* female which was only accepted by some *F. fusca* workers after some days of fighting. She had evidently suffered in the struggle, for ten days after her acceptance she died.

In one of WASMANN's experiments where a *F. rufa* female was adopted into a *F. fusca* nest which contained a *F. fusca* female, in May 1909, the *F. rufa* female, after a few days, killed the *F. fusca* female, and bit off her head.

The last writer states that during twenty years he always found that *F. rufa* and *F. pratensis* females, kept alone, died before laying eggs. We found in March 1912 that though old *F. rufa* females lay eggs when isolated, they pay no attention to them, but leave them scattered about where they have fallen.

We now give some of our own experiments.

In January 1910, DONISTHORPE placed some forty workers of *F. fusca* v. *fusco-rufibarbis*, from Whitsand Bay, Cornwall, in one chamber of a two-chambered Fielde-Janet nest, blocking the passage between the two chambers with cotton-wool. In the

empty chamber he placed an old *F. rufa* female from Nethy Bridge, Scotland. After a few days to allow the female to get rid of her "nest aura," as would be the case in nature, the barrier was removed. Several workers entered her compartment, and she repeatedly entered their compartment and returned, at first avoiding the workers. On February 2nd she was attacked, but regained her own compartment, which now contained five workers. The barrier was then replaced, leaving the female with the five workers. Next day she was attacked and killed one persistent worker, after first attempting to conciliate it. The remaining workers appeared more friendly, and later one fed the female. Other workers were now allowed to enter, which the female stroked with her antennæ. On February 6th, however, she was again attacked by one, which she killed. The other workers were then introduced gradually, only one attacking her and being killed. By February 9th all the workers had been introduced and were quite friendly. Later she was again fed by a worker and was clearly adopted. On March 1st she laid eggs, which came to maturity on June 20th. The callow workers, however, were cripples. The larvæ and eggs had been attended to by the *F. fusco-rufibarbis* workers. She laid again on November 20th, and again on July 27th, 1911. On August 16th, 1911, over twenty pupæ were present, five of which hatched on September 25th, when there were over thirty pupæ. All these pupæ hatched by November 1st and were perfect, though small, *F. rufa* workers. The *F. rufa* female, having lived in the nest for nearly two years, died on October 5th, from what cause is unknown, but it was certainly not through attacks by the *F. fusco-rufibarbis* workers. On March 29th, 1912, an old *F. rufa* queen from Weybridge was introduced to this colony. She was considerably attacked by the *F. fusco-rufibarbis* workers, but only slightly by the small *F. rufa* workers. She killed two of the former, and on the 21st she was quite at home in the nest. She laid eggs which were tended by the *F. fusco-rufibarbis* workers, and became larvæ. This female died on April 5th, and her larvæ were eventually devoured by the workers.

The next experiment shows how, when there is a *F. fusca* female present, she may be got rid of. On April 17th, 1910, DONISTHORPE had a small colony of *F. fusca* with three females

from Darenth Wood in a four-chambered Janet nest. An old *F. rufa* queen from Wellington College was placed in the fourth chamber, the *F. fusca* colony then occupying the second. Next morning the *F. rufa* female was in the first chamber, past the *F. fusca* colony, with three workers, and was not being attacked. During the day she was attacked by three other workers, which she tried to conciliate. Another dragged her into the second chamber by the jaws, where she was accepted by the remaining *F. fusca* workers.

On June 1st one of the *F. fusca* females was found bitten in two. Though this action was not actually witnessed, there is little doubt that it was the work of the *F. rufa* female. Later there were eggs in the nest, but it was impossible to say whether the *F. rufa* female had laid any of them. On June 20th the *F. rufa* female died, but not from violence. Up to November 26th the abdomen of the dead *F. rufa* female was carried about by one of the workers. It appears that for a time, at any rate, the *F. rufa* and *F. fusca* females may live amicably together.

On May 6th, 1911, DONISTHORPE introduced an old *F. rufa* female from Wellington College into a *F. fusca* nest from Porlock. She was attacked, and as usual tried to conciliate her assailants. Eventually she killed one of the more persistent workers, and by May 13th she was definitely accepted, and used to sit together with the two *F. fusca* females belonging to the nest, but made no attack on them. In July she unfortunately died. It might, perhaps, be possible for a *F. rufa* and *F. fusca* female to join together to found a colony (as suggested by VIEHMEYER for *F. sanguinea* and *F. fusca*).

DONISTHORPE has made some experiments on this point, in one of which a *F. rufa*, a *F. fusca*, and a *F. sanguinea* female were placed together on July 22nd, 1911, but on July 23rd the *F. fusca* female actually killed the *F. rufa* female. Again, on March 29th, 1912, a *F. rufa* female from Weybridge was introduced to two Irish *F. fusca* females in a small plaster nest. She was attacked by them, and one pursued her persistently. On March 30th all three females were sitting together. On March 31st the *F. rufa* female and one of the *F. fusca* females were stroking each other with their antennæ and feet and feeding

each other. On April 15th the *F. rufa* female died, but not from violence.

We do not wish here to enter upon the vexed question of the origin of the slave-making instinct and its connection with the habit of Temporary Social Parasitism, but there seems clear evidence that the raiding habit of *F. rufa* workers shows itself occasionally in the females. It is well known that *F. rufa* will attack nests of other ants and pillage their brood, and in some cases will even rear the latter. CRAWLEY has shown that *F. rufa* colonies in captivity will carry off pupæ of their own species, of *F. sanguinea*, *F. fusca* and its races, *L. niger* and *L. flavus*, but seldom those of *Myrmica*. These pupæ, especially those of *L. flavus* and *L. niger* females, were often kept for weeks, but eventually eaten. In May 1912, however, a captive colony of *F. rufa* carried in over a dozen female pupæ of *F. sanguinea*, very few of which were devoured. On July 8th one hatched, and the young female was carefully extracted from the cocoon and cleaned, but no sooner was she able to walk than the workers began to attack her, eventually killing her. CRAWLEY had a colony of *F. sanguinea* from Wellington College, in 1908, which, in addition to the ordinary *F. fusca* slaves, possessed a number of *F. rufa* slaves, hatched from pupæ carried in by the *F. sanguinea* workers. In 1911 a strong *F. rufa* colony from Porlock was placed on the same tray. Some of the workers from this colony entered the *F. sanguinea* nest, where they were unmolested, owing perhaps to the *F. sanguinea* workers having become accustomed to the presence of *F. rufa* in their nest. Next day the new *F. rufa* colony invaded the *F. sanguinea* nest and kidnapped all the *F. rufa* slaves belonging to the latter, and carried them to their own nest. They also carried in a number of *F. sanguinea* workers, who allowed themselves to be taken without resistance. The following day the kidnapped *F. sanguinea* were found dead and thrown out of the nest, but the captured *F. rufa* workers were at home in their new quarters.

WASMANN records in 1909 that he had two *F. rufa* females which robbed the pupæ from a weak *F. fusca* nest and assisted the callows to hatch. In June 1912 CRAWLEY placed three *F. rufa* females in the fourth chamber of a four-chambered

Janet nest, of which the first chamber was occupied by five *F. fusco-rufibarbis* workers, two females, and a number of worker and female pupæ. One of the *F. rufa* females invaded their chamber and eventually killed all the workers. Later on a number of pupæ were found in the chamber occupied by the three *F. rufa* females, a female being seen on several occasions carrying pupæ in. The stolen pupæ in all numbered forty-two, including two female ones. Finally one of the *F. fusco-rufibarbis* females was found in the *F. rufa* chamber, and the other was being carried in by a *F. rufa* female. The two *F. fusco-rufibarbis* females were then left alone and uninjured, but died in a few days' time.

On June 17th, 1912, CRAWLEY placed two old queens of *F. fusca*, v. *glebaria*, in one dark chamber of a two-chambered plaster nest. A deälated fertile female of *F. rufa*, picked up at Woking after the marriage-flight, was placed in the other and light chamber. She soon entered the dark chamber and approached the two *F. glebaria* females, who threatened her. She entered their compartment several times, but continually meeting with hostility, returned to her own, where she remained for some days, till the termination of the experiment.

TEMPORARY SOCIAL PARASITISM IN THE GENUS LASIUS

It is established without doubt, not only from the experiments to be outlined below, but also from numerous observations in nature, that Temporary Social Parasitism exists in an advanced stage among certain species of *Lasius*, viz. *umbratus*, *mixtus* (and probably the others of this group), and *fuliginosus*.

The females of these species have proportionately smaller abdomens than those of *L. flavus*, *L. niger*, etc., which found their colonies unaided, and some (e.g. *fuliginosus*) are considerably smaller altogether in comparison with their workers. They also share the peculiarity of possessing large, broad heads. So far as we are aware, the first instance of a mixed colony of *Lasius* was that observed in Sweden by ADLERZ, in 1895. He found a *L. niger* colony containing a number of *L. flavus* workers which assisted the *L. niger* workers to carry off the brood. As WASMANN suggests, the workers that ADLERZ took to be *L. flavus* were

more likely *L. umbratus* of the first brood, which always consists of small ants.

ADLERZ's explanation of this mixed colony was that the *L. niger* workers had pillaged some *L. flavus* pupæ and hatched them. This is, however, very improbable.

CRAWLEY first proved by experiment that queenless colonies of *L. niger* will accept fertile females of *L. umbratus*, and bring up the offspring of the latter until the colony becomes a mixed one of the yellow and black ants.

In August 1896 he procured a nest of *L. niger* containing a queen, near Oxford. There were about 400 workers, worker and female pupæ, and a large quantity of eggs. The queen, however, had been injured during the operation of digging up the nest, and died. A fortnight later he picked up a newly-deälated female of *L. umbratus* in the same neighbourhood, and placed her in a box with two *L. niger* workers, which she immediately killed. A day or two later, however, she was perfectly friendly with some other *L. niger* workers. She was thereupon put in a box with four workers from the captive and now queenless colony, and was also friendly to them. Later on the same day he removed the lid of the box and placed it near the door of the nest. The workers immediately entered, and were followed in a few moments by the queen, who entered the nest of her own accord. In a few seconds the whole nest was in a turmoil, swarms of ants collecting round the female and saluting her. One ant only attacked her for a short time, and she was soon completely hidden under a mass of workers.

A few days later the ants killed the young winged *L. niger* females that had come to maturity in the nest. *L. umbratus* females do not appear to lay eggs until the year following their impregnation, and this queen began to lay on June 26th, 1897, so that all the ants that came to maturity in this year were *L. niger*. The next year also all the workers produced were *L. niger*, from parthenogenetic eggs laid by workers. The offspring of the *L. umbratus* queen must have been devoured in the egg or larval stage.

In 1899 the eggs of the *L. umbratus* queen were at last allowed to reach the pupal state, and the fragments of an *L. umbratus* callow were discovered on August 10th. From this date up to

September 20th, between three and four hundred *L. umbratus* workers were observed to hatch, some being killed as soon as they emerged, and others after a day or two. None were allowed by the *L. niger* workers to live longer than this, and some of the pupæ were stripped of their cocoons and thrown out of the nest. Most of the dead workers were given to the larvæ as food. The following year the pupæ began to hatch in the beginning of July, and the young workers were not molested by their hosts. By the 18th there were twenty *L. umbratus* workers alive and well, assisting the *L. niger* workers to tend the brood. None were attacked or molested in any way. Unfortunately the nest had to be left for over two months without attention during CRAWLEY'S absence, and on his return the only ant alive was the queen. A striking point was that there was not a single *L. niger* amongst the hundreds of dead *L. umbratus* workers.

The difficulty of obtaining newly-fertilised females of *L. umbratus* prevented a repetition of this experiment until the year 1908. In September 1908 CRAWLEY found several deälated females of *L. umbratus* wandering on a road near Nottingham. Two were taken and enclosed in boxes with *L. niger* workers from a queenless nest taken in July. The females, as in the 1896 experiment, instantly killed the workers. Another *L. niger* was put with one of the females, who killed it also. Next day another *L. niger* was put with her, and this time she was friendly, so five others were introduced, and no hostility was observed—indeed, the female and the workers saluted and caressed each other.

A few minutes after the introduction of the last worker, the box was placed close to the door of the *L. niger* nest, and the lid removed. The workers entered their nest, but the female remained in the box. In less than two minutes after the first worker entered the nest, more than sixty ants came out, found the *L. umbratus* female, and surrounded her, amid great excitement. Still surrounded by workers, she entered the nest, and was evidently adopted as queen.

The following morning the workers were found to have killed all the young winged *L. niger* females in the nest, as in the former experiment. The *L. umbratus* queen began to lay in May 1909, and some of her eggs hatched in June, but only *L. niger* workers

came to maturity in that year. The following year the queen began to lay late in May, when there were already some pupæ in the nest. These pupæ began to hatch in July, and proved to be *L. niger* workers, so they must have been the offspring of the *L. niger* workers, as in the 1896 experiment. Nothing but *L. niger* workers came to maturity during the year, so the eggs or larvæ of the queen must have been devoured as before.

In 1911 the pupæ began to hatch on July 11th, when four callow *L. umbratus* workers were observed. Numbers came to maturity during the summer, and were unmolested by the *L. niger* workers, and by the autumn the colony contained about equal numbers of *L. umbratus* and *L. niger*.

This summer the first callows hatched in July, and, judging from the number of pupæ, by the end of the year the *L. umbratus* workers will outnumber the *L. niger* workers by about two to one.

The *L. umbratus* of this and the 1896 colonies have all been of uniform and small size, and those now in the former nest have more the habits of *L. niger* than of *L. umbratus*. The latter do not pay much attention to the queen, who is generally surrounded by a bevy of *L. niger* workers.

LORD AVEBURY has found that workers of *L. niger* will live seven years or more, and some of those in this colony must be four or more years old: a colony of *L. umbratus*, therefore, founded by adoption in this manner, must take more than five years to become exclusively *L. umbratus*.

CRAWLEY, in September 1910, experimented with artificially deälated females of *L. umbratus* and two queenless colonies of *L. niger*, and found the females readily accepted.

The act of removing the wings, however, was far from arousing the instincts possessed by a fertilised female, as is the case with females of *F. rufa* and *F. sanguinea*, and these females, though they lived for several months in the *L. niger* nests, were restless and tried to escape, and when the entrance to one of the nests was left open, one escaped and was lost.

Judging from these experiments, which were made with populous colonies of *L. niger*, and not with nests containing a few workers, the *L. umbratus* female is adopted in the true sense of the word, is willingly received and even escorted into the

nest by the workers, and has to overcome little or none of the opposition that is encountered by the temporary social parasites of the genus *Formica*.

An experiment which remains to be made is the introduction of a young fertile female of *L. umbratus* to a nest of *L. niger* which contains a *L. niger* queen.

We know of three cases of mixed colonies found in nature, one of *L. umbratus* and *L. niger*, another *L. umbratus subumbratus*, and the third *L. mixtus* and *L. alienus*.

WASMANN, in August 1909, discovered near Lippspringe, in Westphalia, a populous colony composed of about 1,000 *L. niger* workers, one hundred *L. umbratus* workers, and several males and one winged female of *L. umbratus*. WHEELER records in 1910 that six deälated females of *L. umbratus subumbratus* were found by REIFF at Bedford, N.S., living in three colonies of *L. niger*, v. *neoniger*.

DONISTHORPE, at Weybridge on July 28th, 1912, found a nest of *L. alienus* containing a deälated female of *L. mixtus*. He dug up the nest thoroughly, and no other female was present. There was a number of pupæ, but no eggs or larvæ in the nest, and the pupæ have since proved to be *L. alienus*. Eggs were laid by the female this August. We should judge this *L. mixtus* female, therefore, to have been adopted last summer.

This discovery completes the chain of evidence by giving us an example in nature of the initial stage of Temporary Social Parasitism in the *L. umbratus* group.

L. fuliginosus often founds new colonies by branch nests, in a similar way to that employed by *F. rufa*, *F. exsecta*, and *F. sanguinea*. This accounts for the fact that many colonies are found in the districts where this ant occurs.

It is highly probable that there are often a fair number of queens in a nest of this species. This would be accounted for by the reception of newly fertilised females back into the parent nest. Such an occurrence was actually observed by CRAWLEY at Ouchy, Switzerland, in May 1905; copulation, therefore, must have taken place close to the nest, and this is probably the general rule.

DONISTHORPE, at Wellington College, in July 1911, observed

the females and males leaving the nest, which was in a stump, and running up the twigs, where copulation took place.

Occasionally, however, deälated females are found wandering about in localities some distance from nests of *L. fuliginosus*. CRAWLEY found one at Oddington, near Oxford, about 100 yd. from a nest, and another near Esher in August 1899, where there was no nest near. In such cases as these, females would not be likely to be received back into their nests. However, when isolated, they display no desire to build cells in the manner of the normal founding species. CRAWLEY, in May 1905, isolated some newly-deälated females at Ouchy, and put others with workers from their own nest, but none of the females settled down, and the workers did their best to escape. Eventually all the females perished. From the above facts alone, therefore, it seems doubtful that the female *L. fuliginosus* can found a colony unaided. Several discoveries in nature point to *L. umbratus* or *L. mixtus* being the host-species of *L. fuliginosus*. DONISTHORPE found at Lymington in 1897 a large colony of *L. fuliginosus* in a hollow tree, and *L. umbratus* was undoubtedly living with it, as workers of both species were going in and out of the same holes.

CRAWLEY, in 1898, repeatedly found workers of *L. umbratus* walking unmolested with the workers of a large nest of *L. fuliginosus* established under his house near Oxford. Some of these *L. umbratus* were placed in an observation nest composed of workers and larvæ from the above colony of *L. fuliginosus*. They lived for some time in the nest, were fed by the *L. fuliginosus* and tended the larvæ, and were only occasionally attacked. In September 1900 TUCK sent to DONISTHORPE a worker of *L. umbratus* taken in a nest of *L. fuliginosus* at Bury St. Edmunds.

In 1904 DE LANNOY found at Knocke-sur-Mer a few workers of *L. mixtus* in the midst of a large colony of *L. fuliginosus*, and on good terms with the workers of the latter.

In 1906 he again found workers of *L. mixtus* in several *L. fuliginosus* nests. FOREL and EMERY, commenting on DE LANNOY'S observations, expressed the opinion that the presence of these *L. mixtus* workers was due to the fact that fertile *L. fuliginosus* females had entered nests of the former species

and been accepted. The queens of the *L. mixtus* had then died and been killed, and the offspring of the *L. fuliginosus* reared by the *L. mixtus* workers. In course of time many of the latter had died off, and the few found in the nests were the survivors of the original *L. mixtus* colonies. WASMANN also agreed with this view.

Accordingly we determined to test this hypothesis by experiments on captive colonies. In July 1910 a nest of *L. fuliginosus* was dug up at Darenth Wood, containing a quantity of workers, larvæ, males and winged females, but no queen. The ants and brood were divided into two equal portions and each established in a Janet nest.

During July all the males died, and most of the females, with the exception of about twelve, which were found to be deälated. As some of these latter subsequently laid eggs, which are now nearly full-grown larvæ, it is highly probable that mating had taken place inside the nests.

In the beginning of December a nest of *L. umbratus* without a queen was obtained at Weybridge, and divided into two equal portions, which were established in Janet nests.

The first experiment was made on December 10th, when one of the deälated females of *L. fuliginosus* was placed in the light chamber of one of the *L. umbratus* nests. She immediately entered the most crowded chamber. One worker saluted her, and another dragged her further in by a mandible. Eventually, however, she was attacked and killed by the evening.

On December 13th another deälated female was put into a small nest with a dozen workers from the same *L. umbratus* nest as in the former experiment. She was slightly attacked, but made no resistance, and endeavoured to conciliate her assailants by stroking them with her antennæ. Other workers were added, and on December 20th she was put with the workers into the *L. umbratus* nest. She was a little attacked, very likely by the workers who had not seen her before, but very soon all hostility ceased, and she was evidently accepted. Many workers surrounded her, and caressed and fed her. All went well till April, when, a number of the workers having died off, some 400 more were obtained from the Weybridge nest and introduced. These newcomers attacked the queen, though

they were quite friendly with their sister workers. As they persistently refused to accept her, and it was now impossible to remove the newcomers, she was removed.

On December 10th a deälated *L. fuliginosus* female was placed with a single worker from the other *L. umbratus* nest, who threatened but did not attack her. Three others were then introduced, and only one attacked her for a few moments. Next morning the workers were returned to their nest, and the female put in after them. She was threatened, but not actually attacked at first, though later some workers held her by the legs. She was slightly attacked from time to time, and it was very interesting to see how patiently she stroked and caressed her assailants with her antennæ.

After December 16th she was never attacked, and was completely accepted, never being without her court of workers. This queen was accepted by the phlegmatic *L. umbratus* workers with none of the excitement with which the above-mentioned *L. niger* colonies received the *L. umbratus* queens.

On March 22nd, 1911, a second deälated female was put in the nest, and immediately accepted without any hostility whatever, and during April two more were just as readily received. These two latter were, however, subsequently removed. In May some strange workers from colonies at Woking and Wellington College were put into the nest, and readily received by the workers. They attacked the *L. fuliginosus* queens from time to time, but finally desisted. The two queens began to lay on May 17th, 1911, for the first time, and the eggs hatched on August 9th. The larvæ lived through the winter, and at the moment of writing (July 31st) are nearly full-grown. Their development has been very slow, though the nest has been supplied with abundance of animal food and honey.

The queens began to lay this year on June 29th, and they have already laid more eggs than during last year.

CRAWLEY has already demonstrated that females of *L. umbratus* do not lay until the year after impregnation, and the above experiments show that such is the case with *L. fuliginosus*. As the females of the latter are only slightly larger than the workers, and as their fertility is delayed for so long a period, we are satisfied that it is clear that they are unable to found

colonies unaided. *L. fuliginosus* is thus a case of hyper-temporary social parasitism.

It should be noted that the *L. umbratus* workers of this colony readily took in pupæ of *L. niger* and *L. flavus*. Some, including all the female pupæ, were used as food, but others became workers and lived unmolested in the nest for some time.

FOUNDING OF COLONIES BY THE SLAVE-MAKER, *F. SANGUINEA*.

It is no less true in the case of *F. sanguinea* than with species of the *F. rufa* and *F. exsecta* groups, that the females are unable to found colonies alone. As WASMANN has shown, the founding of *F. sanguinea* colonies is chiefly brought about by branch and twin nests, which gradually spread over a large area. After the marriage-flight the young females are received back into some of these nests, but a female is received with the greatest hostility into a strange *F. sanguinea* nest.

In September 1908 CRAWLEY found a deälated female wandering about at Wellington College. She was attacked by the workers of several different colonies in the neighbourhood to which she was introduced. She was repeatedly attacked when placed in a nest from Wellington College during the autumn and winter, but in March 1909 workers from the same nest of their own accord carried her into their nest and adopted her.

Again DONISTHORPE had a nest from Woking taken in 1910, whose queen died on May 1st, 1911. On the 5th a female, also from Woking, was introduced to this colony and accepted. On the 27th a worker, a slave (*F. fusca*), and another female from another nest at Woking were introduced. The workers were killed, and the female accepted. Both these females are alive and well to-day in the nest, and broods have been brought up from their eggs. The acceptances were also in the spring, when the ants perhaps feel the want of a fertile female more than in the autumn.

It has been proved that isolated females do not bring up their own eggs. DONISTHORPE in 1909 took a number of old fertile females and isolated them in bowls, with damp sponges and sand. They remained for months without laying or excavating in the sand, and eventually died. Others he isolated

under similar conditions in 1910, laid eggs which were left scattered about, were never attended to by the ants, and did not hatch.

The females eventually died. When pupæ of *F. sanguinea* and *F. fusca* were introduced, the females sometimes collected them together, and rested on the top. The females of *F. sanguinea*, therefore, are just as incapable of looking after their own eggs as those of *F. rufa*, though they pay more attention to the pupæ than do the latter. VIEHMEYER, in 1909, records similar experiments with the same results.

There are few instances of incipient colonies of mixed *F. sanguinea* and *F. fusca* having been found in nature.

WASMANN records that he once found at Exaten in Holland a dead *F. sanguinea* female in a *F. rufibarbis* nest, held by the legs and antennæ by a number of the *F. rufibarbis* workers.

The youngest colony he ever found in the same place, on May 23rd, 1889, contained about ninety *F. fusca* workers, a female *F. sanguinea*, and only five freshly-hatched workers of the latter.

SCHMITZ saw in the summer of 1898, near Exaten, a *F. sanguinea* which endeavoured to enter the different doors of a *F. fusca* nest. She went into one door, then came out and entered another, and so several times backwards and forwards. He says the numerous *F. fusca* workers about did not hinder her, but is unable to remember if she was finally accepted.

VIEHMEYER in 1909 records that, in company with FOREL and WHEELER in the Rhônetal, he found a small *F. sanguinea* colony which contained two females, a few small *F. sanguinea* workers, some small *F. rufibarbis* workers, and about six pupæ. The *F. rufibarbis* workers had only just hatched, and the pupæ proved to be *F. rufibarbis*. Again in the middle of August, near Dresden, he found under a stone in a small earth-hole a *F. sanguinea* female, two very small *F. sanguinea* workers, and three equally small *F. fusca* workers. On searching further he found a *F. fusca* female, two more *F. fusca* workers, and some pupæ. This made him think of an alliance between the *F. sanguinea* and *F. fusca* females, the *F. sanguinea* workers being certainly younger than the *F. fusca* workers.

He put a *F. sanguinea* and *F. fusca* female together, and in

four days they were quite friendly and sat together. Subsequently the nest went wrong, and they both died on the same day.

On May 5th, 1911, DONISTHORPE put a *F. sanguinea* female from Woking into a small plaster nest containing a single *F. fusca* female from Ireland with eggs. After living together for some days in amity, first the *F. fusca* and then the *F. sanguinea* female escaped, the nest having been disturbed.

On May 10th he put an old *F. sanguinea* female from Woking with three *F. fusca* females from Ireland, one of whom had laid eggs. They attacked the *F. sanguinea* female intermittently, and she died on May 15th.

On May 27th another old fertile female was put with a *F. fusca* female. The *F. sanguinea* female was dead on June 1st.

On July 22nd a *F. fusca* female, an old fertile Weybridge *F. sanguinea* female, and a *F. rufa* female from Parkhurst Forest, were put into a small plaster nest. On July 27th the *F. fusca* female killed the *F. rufa* female (as quoted above under *F. rufa*) and the *F. sanguinea* and *F. fusca* females remained friendly. On July 31st the *F. fusca* was cleaning the *F. sanguinea*. They lived amicably together and were often noticed to feed each other, till August 6th, when the nest was left in the sun and both ants were killed.

This year a few more experiments have been attempted. Two *F. sanguinea* females from Bewdley Forest were placed with two *F. fusca* females from the Isle of Tiree. The *F. sanguinea* females killed the *F. fusca* females.

Another Bewdley Forest *F. sanguinea* female was placed with a Tiree *F. fusca* female. These two have made friends, and are living together amicably to-day.

We now come to the experiments on the behaviour of *F. sanguinea* females, when introduced to colonies of *F. fusca* and its races. WHEELER's experiments in 1905 show that in the American subspecies of *F. sanguinea* (*rubicunda*), the female has the pillaging instinct as strong as the workers. In one case an unfertilised deälated female, introduced into a small colony of *F. subsericea* with no queen, stole the pupæ and eventually killed off all the workers. In similar experiments with *F. aseræa* and *F. glacialis* he obtained the same results. WASMANN, on

the other hand, performed experiments with young fertile females of the European *F. sanguinea*, and found that the *F. fusca* workers adopted them readily. But VIEHMEYER, and WASMANN himself later, found that *F. sanguinea* females pillaged the cocoons and killed the *F. fusca* workers. It seems fairly clear that this violent method is the more general.

DONISTHORPE'S experiments, particularly the more recent ones, support this theory.

Experiments in 1909.—No. 1. An artificially deälated *F. sanguinea* female, taken at Aviemore, was introduced on June 24th to a small queenless *F. fusca* nest from Sherwood. The workers ran away but finally attacked the female, who killed six or seven of them. On the 28th the female appeared to be accepted by the workers, as they were all sitting together and some of the workers were cleaning the female, but on July 2nd she was dead.

No. 2. On July 4th an old female from Woking was introduced into a small colony of *F. fusca* workers with pupæ. The female approached the pupæ and seemed interested in them. The workers removed the pupæ, the female was attacked and repulsed the workers. The female and workers then fed side by side at some honey. Next day the female had collected all the pupæ into one corner and was reposing on them. Two workers were with her, but several others were dead and injured. The following day only three workers survived, and the female was still in possession of all the pupæ. The three workers removed pupæ from time to time, but the female brought them back. Some strange *F. fusca* larvæ and pupæ were put into the nest and collected by the female. On the 15th only two workers were left and appeared to be friendly with the female, all being together on the pupæ. On July 18th all were well and friendly.

No. 3. On July 15th a small *F. fusca* colony of workers with pupæ, from Shotover, near Oxford, was placed in a combined Fielde and Janet nest with a deälated *F. sanguinea* female from Woking. The female was at once fiercely attacked, but was not very aggressive herself. Next day she had lost an antenna, but was not attacked. July 17th she was alone, but not attacked, and on July 18th she was dead.

No. 4. An artificially deälated female *F. sanguinea* from

Aviemore was introduced to a small colony of *F. fusca* v. *fusco-rufibarbis*, from Whitsand Bay, on July 17th. She approached the pupæ but was fiercely attacked and killed the same day.

No. 5. A similar experiment to No. 4, but the female killed two workers before she was herself killed on the following day.

Nos. 6 and 7. Two artificially deälated females from Bewdley were introduced into two *F. fusco-rufibarbis* colonies on July 23rd, and both were killed the same day.

No. 8. July 23rd a small colony of *F. fusca* workers killed an artificially deälated *F. sanguinea* female introduced the same day.

No. 9. The wings were removed from a virgin *F. sanguinea* female from Bewdley, and she was placed in a small queenless colony of *F. fusca* from Shotover on July 24th. She was attacked by two workers, which she killed. Later she captured some pupæ and piled them in a corner. She injured a worker who attacked her, and killed another. On the 25th all the workers but one were killed, and the female was resting on the pupæ in a corner.

No. 10. July 25th a virgin deälated female from Bewdley was killed in two hours by *F. fusca* v. *fusco-rufibarbis* workers.

No. 11. July 25th a virgin deälated female from Bewdley killed several *F. fusco-rufibarbis* workers, but was dead the next day.

No. 12. A similar female was much attacked by *F. fusca* v. *fusco-rufibarbis* workers and was killed the next day.

No. 13. August 9th a virgin deälated Bewdley female was put with six workers and pupæ of *F. fusca* v. *fusco-rufibarbis*. She was immediately attacked and killed.

In none of these thirteen experiments was a *F. sanguinea* female accepted by workers of *F. fusca* v. *fusco-rufibarbis*, and only in two was the female successful, in one after killing all but two of the workers and in the other after killing all. In every one of WHEELER's experiments with queenless nests of *F. glacialis*, the female of *F. subintegra* was either killed by the workers, or succeeded in stealing the pupæ and killing all the workers.

In our more recent experiments carried out this year, even more marked results were obtained

On July 15th, 1912, CRAWLEY placed a virgin winged female

of *F. sanguinea* from Woking in a chamber of a Janet nest next to one containing six workers and pupæ of *F. fusca* v. *fusco-rufibarbis*, from Seaton, Devon. After once wandering into their chamber and being chased out, she did not leave her own chamber. On the 17th her wings were artificially removed. Next day she was dead in the *fusco-rufibarbis* chamber.

At 3.45 p.m. on July 19th a virgin artificially deälated female of *F. sanguinea* from Woking was placed in a chamber adjoining the same *F. fusco-rufibarbis* workers and pupæ. At 4.20 p.m. she was seen to be carrying a pupa into her chamber, which now contained eight pupæ. Three of the five workers and a male recently emerged were also in her chamber. She then entered the other chamber and attacked a worker, who escaped from her. Another worker, who tried to take away a pupa she was carrying, was killed. At 4.35 she had killed another, and both this and the other dead one were hanging to her legs. She pranced about the nest with open jaws whenever light was let in. At 8.0 p.m. she killed another worker and chased the remaining two. Next day she was repeatedly attacked by the two workers, but never attempted to retaliate, and up to July 31st she has never attacked the workers again, though they occasionally pull her antennæ and legs.

On July 25th a similar deälated female of *F. sanguinea* was placed in the light chamber of a nest of *F. fusca*, containing a queen, over one hundred workers, and pupæ taken some years ago in the New Forest. She was immediately seized and overpowered, and made no resistance. Another put in the same nest shortly afterwards was overpowered and killed.

Another was placed in the light chamber of a nest containing eight queens, about 130 workers, and pupæ of *F. fusca* v. *glebaria*, from St. Issey, Cornwall. She was at once overpowered and killed. Another the same day was placed with ten workers of *F. fusca* and a number of pupæ from the New Forest. She was found dead a few hours later.

Again, on July 25th, a similar female was placed in a glass-topped box containing two workers and a quantity of pupæ and one callow of *glebaria* from the New Forest. The two adult workers immediately seized two pupæ and fled to the top of the box, where they remained, holding the pupæ for two days

without having been observed to move. The *F. sanguinea* female took no notice of workers or pupæ till the next day, when she collected the pupæ together and rested on them with the callow. More callows hatched from day to day, and the two mature workers were found dead on the 28th. By the 31st there were ten callows with the female on the pupæ, and all were on good terms.

On July 27th another deälated female was placed in the light chamber of the nest of *F. fusca* with queen and a hundred workers. She remained in a corner for two days, and the *F. fusca* workers blocked up the entrance to the next chamber. However, on the third day they came out and killed her.

DONISTHORPE, on July 2nd, 1912, took one of the tame queens out of his observation nest of *F. sanguinea* and put her in the light chamber of a four-chambered Janet nest. The nest contained a colony of *F. fusca* from Porlock, consisting of two *F. fusca* females, many workers, and a large number of cocoons, which occupied the second chamber. In the third chamber, the one next to the *F. sanguinea* female, a number of the *F. fusca* cocoons were placed and the passage to the *F. fusca* apartments was blocked up with cotton-wool. The *F. sanguinea* female soon entered the third chamber and sat on the pupæ. On July 3rd she was still on the pupæ, and the cotton-wool was removed. Some of the *F. fusca* workers entered her compartment. Some threatened her, and ran away, but others attacked her, and others again took away the cocoons. She killed two workers during the combat. The *F. fusca* workers then retired, and she was left alone. Later the female was placed in the compartment occupied by the whole *F. fusca* colony. Nearly all the ants bolted, but a few workers attacked her. She escaped and returned to the light chamber. She never tried to enter the nest again, and her one desire appeared to be to escape, and subsequently three or four workers came in and fastened on to her legs and antennæ. As it was feared she would be killed, she was then returned to her own nest. Here she was pulled about by her own workers for the rest of the day, but on the following day she was treated as usual, and is still alive and well.

On July 8th a *F. sanguinea* female from Bewdley Forest was placed into the Porlock *F. fusca* nest among the ants. Most

of them bolted and carried off their cocoons, whilst several attacked her. She became angry and eventually killed six workers. At 5.45 p.m. the female was alone with the dead and injured workers. On July 9th the *F. sanguinea* female was alone, the *F. fusca* workers had carried off all their dead, and had blocked her in with sand. During the day she died, probably from injuries received.

On July 9th a winged *F. sanguinea* female from Woking was placed in the Porlock nest, her wings having been first removed. She at once rushed in among the *F. fusca* colony, killed several *F. fusca* workers, and was then held by a large number and soon killed.

On July 10th another *F. sanguinea* female from Bewdley was placed in the light partition of the Porlock nest, and blocked in, as DONISTHORPE was going away for a few days. On his return, on July 13th, he found the *F. fusca* workers had forced an entrance, the *F. sanguinea* female was dead, and no less than fifteen dead *F. fusca* workers lay beside her.

The experiment next described, which has proved to be successful and is still going on, is dealt with last. On July 2nd DONISTHORPE removed the wings from a young *F. sanguinea* female from Woking and placed her in the light chamber of a small two-chambered plaster nest. The dark chamber contained seven *F. fusca* females, three *F. fusca* workers, a few larvæ, and one cocoon. The small brood had been brought up by these ants, which had been taken from a *fusca* colony at Hainsh, Tisree, in April. The *F. sanguinea* female soon entered the dark chamber, and the *F. fusca* females and workers ran and hid in corners. At 5 o'clock all the latter had gone into the light chamber, except one *F. fusca* female. They had removed the larvæ, but the *F. sanguinea* female had captured the one cocoon which she held in her jaws.

On July 3rd all the *F. fusca* workers had been killed, and the *F. sanguinea* female again held the cocoon in her jaws. The *F. fusca* females were all huddled together in one corner with the larvæ. On July 4th one of the *F. fusca* females had been killed and the *F. sanguinea* female had collected the two largest larvæ and the cocoon. Four of the *F. fusca* females were removed as they were required for other experiments.

July 5th the two remaining *F. fusca* females had been attacked, and one had both antennæ bitten off.

July 7th.—Both *F. fusca* females dead, and the *F. sanguinea* female was sitting on the cocoon and the two larvæ.

July 8th.—A naked pupa from the Porlock *F. fusca* nest was introduced, and the *F. sanguinea* female collected it into her heap.

July 9th.—The female still sitting on her heap. Ten *F. fusca* cocoons were introduced, and she collected them all and placed them with the rest.

July 13th.—The Tيرة cocoon, which was the darkest when the observer left home, was found to have produced a callow, and the empty case had been carried into the next compartment. The larger larva had changed into a naked pupa, and the *F. sanguinea* female and the callow were sitting together on the other cocoons, two naked pupæ, and the small larva.

July 14th.—Another empty cocoon case in the light compartment. As no second callow had hatched, the female must have eaten the contents.

On July 15th a second callow just hatched, and on the 17th a third, whilst a single egg was present !

On July 18th a fourth callow present, and the egg had disappeared. The female still helps to carry about the cocoons.

By July 26th eight callows were present.

Genus *Polyergus*.

There is not quite so much evidence about colony-founding by the other Camponotine slave-maker *P. rufescens*, at any rate in nature, as to the existence of incipient colonies. FOREL, in 1874, records a fairly young *Polyergus-fusca* colony in Switzerland, and WASMANN states that he found in Holland in 1887 a quite young *Polyergus-fusca* colony. Again in 1904 the latter mentions a young *Polyergus-rufibarbis* colony containing about one hundred *rufibarbis* slaves and a third of that number of small *Polyergus* workers which he found at Luxemburg.

The workers and females of *Polyergus* appear unable to feed themselves, though they sometimes drink water, and cannot bring up larvæ and pupæ. The females, moreover, placed in

nests with pupæ, pay no attention to them, as WHEELER has shown with the American subspecies *P. lucidus* and *F. incerta* brood.

A newly fertilised female must, therefore, as insisted on by FOREL and WASMANN, be adopted in some way by the slave species.

The females do not seem to have the instinct of the workers to carry off pupæ, as have females of *F. sanguinea*, so the theory that, as in the case of the latter, a female might pillage a number of cocoons and hatch them out herself, is hardly admissible.

EMERY in his most recent paper suggests the hypothesis that a female might enter a colony of *F. fusca* and frighten away the workers, who would leave a certain number of pupæ behind in their flight. These pupæ would then hatch, as *Formica* callows can emerge from the cocoon unassisted.

There is as yet, however, no direct evidence in support of this view.

FOREL made some experiments in which newly fecundated females were adopted by workers of the slave-species. In August 1869 he found a deälated female of *P. rufescens* on a road. He placed her with ten workers of *F. fusca*; the first worker who met the female seized her by a leg, but released it at once. The workers then joined the female, and all were perfectly friendly.

Unfortunately he neglected the nest and all the ants perished. There was no sign of injury on the bodies, and the experiment would undoubtedly have been successful with the requisite care. In 1872 he found a deälated female being attacked by some of her own species while on a slave-making raid. He rescued the female and placed her with a dozen *rufibarbis* workers. These workers allied themselves to the female at once and lived amicably with her for a week, when the female died.

VIEHMEYER in 1908 introduced a *Polyergus* female into a small colony of *F. fusca* with queen. She was accepted and killed the *F. fusca* queen.

In his recent most interesting paper mentioned above, EMERY discusses the question and gives his experiments. He observed nests for several years and noted that some years there was no regular marriage-flight, and that the winged and deälated females went with the workers on the slave-raids, under

these circumstances. In one experiment in July 1908 the workers of a small *F. fusca* colony attacked the strange female, but the *F. fusca* female was friendly to her. The *Polyergus* female, however, eventually killed the *F. fusca* female by a bite in the head, and the workers thereupon became friendly and adopted her. Next year, on May 5th, the queen laid eggs, which disappeared, and again on May 30th. On June 21st larvæ hatched, and pupated from July 8th onwards. On August 6th the first callow appeared, but only two completed their metamorphosis. During the winter of 1909-10 both the *Polyergus* workers died, and only three *F. fusca* workers were left with the *Polyergus* female.

Another experiment in July 1909, with a larger colony of one hundred *F. fusca* workers and females, resulted in the *Polyergus* female seeking the *F. fusca* female and standing over her, the workers meanwhile pulling at both females. The next day the *F. fusca* female was dead with a pierced thorax, and the *Polyergus* female was adopted. Other experiments confirm the above. EMERY concludes that the grounding of a new *Polyergus* colony can without doubt take place by the entrance of one or more females into a nest of *F. fusca* and its subspecies.

The *Polyergus* female, when not prevented by the workers, seeks the rightful queen of the colony and kills her. The effect of this assassination is that the workers adopt the strange female and eventually bring up her young.

EMERY goes on to say that one would suppose that the adoption of a *Polyergus* female would be more likely successful in a small colony of the slave species of one or two years' standing. This he says was his own view, until his experiments in observation nests caused him to change his opinion. Thus in the experiment quoted above only two small *Polyergus* workers reached maturity, and they died by the winter. He therefore thinks that, in order to be successful in founding a colony, a female must enter and be adopted by a strong colony of the slave species. We do not, however, see why a fair number of workers in a small colony of *F. fusca* should not be able to support the *Polyergus* female and her offspring, for the two or three years that EMERY himself thinks must elapse before the first slave-raid takes place. He also thinks that this will apply to all "robber" ants, including

F. sanguinea. We are unable to agree with this conclusion, since, as we have shown by our experiments, the *F. sanguinea* female was always killed, when introduced into a colony of the slave species containing many workers. EMERY concludes, on his experiments on the subject of food, that ants in small numbers, however well fed, only rear very small workers, yet surely in course of time, as their numbers increased, the large workers which EMERY says are necessary to form an Amazon army would be produced.

As WASMANN states, from his own and other experiments, *Polyergus* females are readily adopted by workers of the slave species without a female, though they are always attacked and killed by their own workers. If, therefore, a *Polyergus* female should happen to find a queenless colony, the matter would be simple.

Genus **Strongylognathus**.

The females of the Myrmecine slave-makers *Strongylognathus*, it is clear, cannot adopt the tactics practised by the females of *F. sanguinea* and *P. rufescens*, owing to their small size and weakness; moreover, the colonies of the host, *Tetramorium cæspitum*, are as a rule on a much larger scale than that reached by *F. fusca*. From the observations of WASMANN and VIEHMEYER, since confirmed by FOREL and WHEELER, it is clear that the presence of the queens of *S. testaceus* in a *Tetramorium* colony does not affect the queen of the latter, who remains in the nest with the parasitic queen. Such colonies reach a great size, one observed by WASMANN in Bohemia containing about 20,000 *Tetramorium* workers and about 1,000 of the *Strongylognathus* with pupæ, and a fertile queen of both species.

WASMANN is of opinion that such mixed colonies were formed by an alliance of the two queens in the first instance, but WHEELER is inclined to take the view that the *Strongylognathus* female enters a colony of *Tetramorium*, after the latter has been established.

Strongylognathus testaceus has nearly, if not entirely, lost the power of making slaves. Nothing appears to be known of the colony-founding of the other species of the genus.

Genus **Bothriomyrmex**.

The method employed by the Dolichoderine parasite *Bothriomyrmex atlantis*, as observed by SANTSCHI in Tunis in January and February 1906, is as follows: The female, after the marriage-flight, wanders about in search of a nest of *Tapinoma nigerinum*, where she is seized and dragged into the nest by the neuters. She appears to be attacked in the nest, but climbs on to the brood, or on the back of the queen, when she seems to be safe from attack. While on the back of the queen, she kills her by cutting off her head. After the death of the *Tapinoma* queen the intruder is less and less attacked, and in the end she is accepted. Eventually the host workers die out and a pure *Bothriomyrmex* colony remains.

FOREL was the first to find a mixed colony, in this case of *B. meridionalis* and *Tapinoma erraticum*, in the islands of Lago Maggiore in 1874.

As we have seen that *T. erraticum*, and others, generally have many queens, it would probably be a rare occurrence for the parasitic queen to succeed in her object.

FOREL in a recent paper suggests that the *Bothriomyrmex* may enter a queenless nest of *Tapinoma* and be accepted. DONISTHORPE some years ago found a nest of *T. erraticum* which contained no queen.

It may be of interest to mention that SANTSCHI thinks the *Bothriomyrmex* female is helped considerably by mimicry, having the size, colour, and also the smell of *Tapinoma*.

Genus **Wheeleriella**.

The degenerate permanent parasite *Wheeleriella santschii*, which has no workers, was discovered by SANTSCHI in Tunis. He showed that after mating, which, as with *Anergates*, takes the form of adelphogamy (the pairing of brothers and sisters), the females leave the parent nest and wander about in the neighbourhood of nests of the host, *Monomorium salomonis*, and seem actually to be assisted into the nest by the *Monomorium* workers, who carry them in when the female does not enter of her own accord. The workers then assassinate their own queen and

adopt the parasite instead. The effect of this is, of course, the gradual impoverishment and extinction of the host colony. There is no completely satisfactory explanation of the assassination of the *Monomorium* queen by her own workers. FOREL thinks it may be due to the preference of the workers for a smaller fertile female, just as *Tetramorium* workers prefer to bring up males and females of *Strongylognathus* rather than their own very large sexes.

Anergates atratulus.

During the sixty years that have elapsed since SCHENCK discovered this extraordinary ant at Weilburg in May 1852, numerous investigators have attempted to discover how the female becomes permanently adopted in a colony of *Tetramorium caespitum*, but the problem has remained unsolved.

It is evident that the newly fertilised female must leave her nest and be accepted in some manner by a colony of *T. caespitum*, and, as neither queens, males, nor pupæ of *Tetramorium* have ever been found in a nest infested by *Anergates*, the host queen must somehow be eliminated.

The mating, owing to the absence of wings in the male, must necessarily take place in the nest between brothers and sisters, though JANET suggested that females might fly to other *Anergates* nests and be fertilised there, which seems improbable. Copulation, both in natural and artificial nests, has been observed by several people. VON HAGENS saw a female leave the nest and fly away, in August 1866, at Cleve; and WHEELER in June 1907 in Vaud, Switzerland, discovered a colony from which female *Anergates* were flying in great numbers.

ADLERZ, in 1886, records a few experiments with *Anergates* females and strange *Tetramorium* colonies, in Sweden. He placed several unfertilised females with a strange colony of *Tetramorium*. The females moved about almost unnoticed among the ants. Nearly the same results were obtained by placing unfertilised females in a strange nest of *Tetramorium* provided with a queen and brood of its own species. A number of larvæ, pupæ, males and females of *Anergates* were well received by a strange *Tetramorium* colony in an artificial nest.

WASMANN in 1891 records similar results in Holland. The strange *Tetramorium* workers did no harm to the male and female *Anergates* that he gave to them, while they killed all the males and females of *Strongylognathus testaceus* that he placed in their nest.

In 1897 JANET records the following experiment. A normal colony of *Tetramorium cæspitum* with a queen, and a normal colony of *Anergates* containing an obese queen, young winged females, males, and *Tetramorium* workers, the two colonies being about equal in numbers, were placed together in an artificial nest. Only a few relatively unimportant encounters were observed, but several days after the obese queen was lying dead among a group of *Tetramorium* workers, who still persisted in tending her. Several weeks later all the *Anergates*, males and females, had disappeared, so that the colony became a normal *Tetramorium* one again. WASMANN in May 1904 found a strong colony of *Anergates* at Luxemburg. Copulation was observed, after which the newly-fertilised females sought to leave the nest. *Tetramorium* worker pupæ from a strange nest of *Tetramorium* were given to the *Anergates* colony, and devoured. During June he placed twelve winged but fertilised *Anergates* females into an observation nest containing one hundred *Tetramorium* workers and worker pupæ. Two pairs of *Anergates in cop.* were among those introduced. The first female was pulled about and her wings broken off, but others were readily received. No female was, however, taken as a queen, and by June 22nd all the *Anergates* had disappeared.

In July 1909 he found under a stone at Hohscheid in Ösling a small *Anergates* colony, but could not discover a fertile queen. A pair of *Anergates in cop.* were taken and put into a small nest of *Tetramorium* without a queen. Two days later the female, still winged, was seen under a number of workers. Two more females, a male, and twenty larvæ of *Anergates* were then put in, and at once received, and the larvæ fed by the workers. The colony perished during August.

WASMANN says that these experiments do not show how a female is made queen of a *Tetramorium* nest. He suggests that a female is adopted in a queenless old *Tetramorium* colony, or perhaps in a branch of an old colony.

WHEELER, as mentioned above, found winged females of *Anergates* escaping from a nest in Switzerland in 1907. Fertilised females were taken and placed near the openings of eight nests of *Tetramorium* in FOREL's garden. The females entered some of the nests without attracting much attention. In other instances the females were carried into the nests by the workers. Males, on the other hand, were treated with some animosity, carried away, and abandoned. One vigorous colony, however, behaved differently: the males and females placed near the entrance were seized, pulled about, and carried some distance away. Late in the afternoon two nests, that had been entered without protest by females in the morning, refused to allow additional parasites placed near the openings to enter.

WHEELER concludes that the reception of the parasites by the *Tetramorium* under natural conditions is not so simple as the observations of ADLERZ and WASMANN on artificial nests would lead one to suppose.

A colony of *Anergates*, consisting of an obese queen, about thirty winged females, a few males, and a large number of *Tetramorium* workers, was dug up in the New Forest on July 23rd and transferred to an artificial nest. The *Tetramorium* workers readily received some strange worker pupæ of their own species, and brought them to maturity. The contrary, it will be remembered, was observed by WASMANN.

On July 24th CRAWLEY observed copulation to take place inside the nest, and some of the females subsequently removed their wings without having made any attempt to leave the nest.

Soon after, one of the newly-deälated females was seen to be dragging a *Tetramorium* worker by the last joint of the club of the antennæ. The worker was doubled up and appeared dead, but in a few moments revived and tried to get free. Several workers examined the pair. Soon four females were observed to be holding workers by the tips of the antennæ: two of these females were deälated, and each of the other two had only one wing remaining. The females dragged the unfortunate workers all over the nest and into the light chamber. Late that evening there were five such pairs; in each case the worker was dragged about on its back, doubled up. Twice workers were seen to pull one of these females by a leg. These females continued to

drag the workers about the nest for several days, when those females that had not been removed for experiments began to die. It is noteworthy that it was in every case immediately after fecundation, and the removal of all or all but one of the wings, that the females seized the workers, invariably by the last joint of the flagellum. The grip of the females' mandibles on the antennæ of the workers seemed to paralyse the latter, who made no resistance, and only in one or two cases tried to escape.

We have made several experiments with some of the females obtained in the New Forest and subsequently fertilised, and now give the details.

Experiment I.—In July CRAWLEY had an old fertile female of *Tetramorium* in a plaster nest with about a dozen workers and a quantity of pupæ. Both the queen and the workers were from the New Forest, but from different nests. The queen was only once or twice attacked, and at the time of the following experiment appeared to have been accepted by the strange workers.

A newly fertilised and deälated female of *Anergates*, still holding her captive worker by the antennæ, was in the afternoon of July 24th placed in this small *Tetramorium* nest. Workers touched her and passed on without molesting either her or the worker. Late the same night the female seemed quite at home among the now more numerous workers and callows. Next day a worker was seen to pull the female by an antenna, and another was biting her thorax. She was attacked from time to time during the day. Her abdomen was slightly distended, so that white appeared between the segments, and a single egg was adhering to the top of her abdomen (the obese queen in the parent nest was often observed to have eggs stuck on her abdomen). She still held on to her captive worker, who seemed nearly dead.

At 6.15 p.m. her captive was released, and she herself was held in the jaws of a worker. She was then removed from the nest and found to be dying.

Experiment II.—On July 24th DONISTHORPE placed a fertilised *Anergates* female with one wing in a nest of *Tetramorium* with queen, taken at Whitsand Bay in July 1911. The female

was pulled about at once by the workers, and shortly after carried into the crowded chamber and lost sight of. Next day her body was found cut up and given to the larvæ as food.

Experiment III.—On July 25th he put another deälated female into the same nest of *Tetramorium*. A worker carried her into the next chamber at 8.30 a.m. At 9.0 a.m. she was walking about and occasionally attacked. She then seized a worker by an antenna and pulled her along. Later she was again attacked, though some workers cleaned her. At other times she was carried about all doubled up. At 10.30 she was free. The nest was unfortunately left in the sun, and at 12.30 p.m. the female was found dead and cut in two. The workers had probably become unduly excited by the heat of the sun, to which they were unaccustomed.

Experiment IV.—CRAWLEY had a large colony of *Tetramorium* from Seaton, Devon, in a Janet nest. It was obtained in June 1912, and consisted of over 1,000 workers, a large number of winged females and males and pupæ.

On July 17th one of the females removed her wings, and two days later another did the same. These females were from time to time caressed by the workers, and may have been fertilised in the nest. This point is important in view of the experiment, as the nest contained no old fertile queen.

At about 11 a.m. on July 25th he placed a deälated *Anergates* female, holding a *Tetramorium* worker by the antenna tip, into the light chamber of this nest. A worker at once attacked the captive worker. At 11.15 the female was held by the back of the thorax, but her captive was not attacked. At 1 p.m. she was in the next and dark chamber, unmolested and still holding her worker. Later she was surrounded by about twenty ants, and her captive had gone. At 6.15 p.m. she was in the innermost chamber with a large court of workers round her. Next day the female seemed to be definitely accepted as queen by the *Tetramorium* workers, some of whom were in constant attendance on her. On the 28th her abdomen was distended so that white showed between the segments. On July 30th both of the deälated *Tetramorium* females in the nest were being attacked by their own workers. Presently they were brought out into the light chamber. Next day they were dead, and

eleven winged *Tetramorium* females and two males were attacked. By the following day all the females and males were dead, and their wings and dead bodies were piled in a corner of the light chamber which the ants used as a refuse-heap. On August 3rd another female hatched, but was killed the same day.

At the moment of writing (August 6th) the abdomen of the *Anergates* queen is twice its normal size, though she has not as yet been observed to lay any eggs.

Experiment V.—On July 29th CRAWLEY placed a fertilised *Anergates* female with only one wing into the small nest of *Tetramorium* employed in Experiment I. When touched by the workers, she crouched down and remained motionless. Later she was dragged by a worker. At 5 p.m. she was holding the tip of a worker's antenna, and the worker seemed paralysed. Another worker was attacking her. At 6.45 p.m. she had released the worker and was attacked by two others. At 9.50 p.m. she seized another worker by the antenna, but did not retain her hold for long. The last observation that night showed her to be held by a leg and an antenna. She was still being attacked the next morning, so the *Tetramorium* queen was removed from the nest. This, however, made no difference, as she was viciously attacked during the day, and so was removed.

Thus it will be seen that in four of the above experiments made on colonies of *Tetramorium* containing old queens, the *Anergates* females were killed or attacked. The single experiment made on a far larger colony without an old queen, but containing two deälated females, which may or may not have been fertilised, and a number of winged females and males, resulted in the complete acceptance of the parasite queen and the subsequent slaughter of all the *Tetramorium* males and females.

There are several other interesting parasitic ants, and also some myrmecophilous species, including our British *Solenopsis fugax* and *Formicoxenus nitidulus*, whose modes of founding colonies are unknown.

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· LE STADE " NATANT " OU " PUERULUS " DES PALINURIDÉS.

Par M. E.-L. BOUVIER, PARIS.

On sait, depuis GERBE, que les Palinuridés ou *langoustes* naissent sous une forme larvaire appelée *phyllosome* et qu'ils mènent alors une existence pélagique. Aplati dans le sens dorsoventral comme une feuille, le phyllosome ne ressemble en rien aux langoustes et, d'ailleurs, présente un genre de vie tout autre, ces dernières étant des " Reptantia " qui marchent et vivent sur le fond. Comment s'effectue la curieuse métamorphose ? on l'ignore, mais ce que l'on sait, depuis les remarquables observations de M. BOAS (1880), c'est que le stade définitif est précédé par un autre, le stade " natant," où l'animal a pris la forme typique des Macroures marcheurs, mais nage au moyen de ses appendices abdominaux, et se distingue en outre de l'adulte par ses téguments coriaces, translucides, où manquent totalement les sillons et, pour une grande part aussi, les épines caractéristiques de l'état parfait.

Dans une note des plus intéressantes, M. CALMAN (1909) a montré que le genre désigné d'abord sous le nom de *Puer* (1891), puis sous celui de *Puerulus*, par M. ORTMANN (1897), s'applique à des immatures du stade " natant," mais que la forme caractéristique de ce stade est conservée à l'état adulte par une espèce, le *Puerulus angulatus*, trouvé par le " Challenger " et décrit par SPENCE BATE sous le nom de *Panulirus angulatus*. Ainsi le nom de *Puerulus* doit être conservé comme terme générique, et, sous la forme du nom commun "*puerulus*," il peut également servir à désigner le stade " natant " des Palinuridés.

Grâce aux riches trouvailles que j'ai pu faire dans les collections du Muséum ainsi que dans les matériaux recueillis par le

“ Blake ” et par la “ Princesse Alice,” je crois être en mesure de justifier complètement les vues de M. CALMAN, et de rapporter aux adultes qui en dérivent certains *puerulus* nouveaux ou déjà connus.

Avant d'entreprendre cette étude il ne sera pas inutile d'observer : 1°, que les genres *Puerulus* (*Puer*) et *Linuparus* (*Avus*) diffèrent des autres langoustes et ressemblent aux *puerulus* en ce sens que leur arceau antennulaire ne présente pas d'épines et que leur carapace est aplatie dorsalement, avec les flancs verticaux; 2°, que certaines saillies céphalothoraciques de l'adulte se trouvent déjà dans le *puerulus*, entre autres les cornes frontales flanquées à leur base d'une épine, l'épine située de chaque côté en arrière de l'orbite et celle qui occupe le sommet antéro-latéral de la carapace; 3°, que l'armature épineuse des pédoncules antennaires des *puerulus* ressemble beaucoup à celle de l'adulte; 4°, que les pédoncules et les fouets antennulaires sont également du même type chez le *puerulus* et chez l'adulte, seulement avec une longueur relativement plus faible dans le premier que dans le second.

La première de ces observations permet de considérer comme primitifs à divers degrés les genres *Puerulus* et *Linuparus*; la deuxième et la troisième ne seront pas sans valeur pour comparer les *puerulus* entre eux et aux adultes qui en proviennent; enfin, la quatrième montre que l'on peut adopter pour les *puerulus* la classification en *brévicornes* et *longicornes* établie par MILNE-EDWARDS pour les adultes.

I.—LES PUERULUS BRÉVICORNES.

MILNE-EDWARDS (1837) caractérise les langoustes brévicornes d'après la structure des antennules et de l'arceau qui les supporte; cet arceau est étroit, de sorte que les pédoncules antennaires sont fort rapprochés et cachent plus ou moins les antennules; ces dernières se distinguent d'ailleurs par leurs fouets, dont la brièveté est assez grande. On peut caractériser semblablement les *puerulus* brévicornes, mais à la condition d'élargir et de préciser la définition précédente. Chez ces *puerulus*, en effet, l'arceau antennulaire n'a pas encore totalement subi la grande réduction transversale qu'il présentera chez l'adulte; sans doute

il est déjà beaucoup plus long que large et en forme de trapèze étroit et haut, mais sa largeur est encore telle que les antennules restent complètement visibles dans l'intervalle assez grand qui sépare les pédoncules antennaires. J'ajoute que chez les *puerulus* brévicornes, comme chez les adultes, les fouets des antennules sont plus courts ou à peine plus longs que la longueur totale des deux derniers articles pédonculaires et qu'ils présentent des dissemblances profondes, le fouet externe étant fort dilaté à sa base, tandis que le fouet interne est filiforme. Comme l'a observé M. BOAS, ces caractères indiquent des affinités homariennes.

Ainsi délimité, le groupe des Palinuridés brévicornes renferme tous les genres de la famille à l'exception des *Panulirus*. On doit y ranger, ce me semble, le genre *Puerulus*, dont l'unique espèce, *P. angulatus*, est représentée par SPENCE BATE (1888) avec des fouets antennulaires fort dissemblables et plus courts que leurs pédoncules ; mais l'arceau antennulaire de cette forme est très développé, si bien que les auteurs rangent l'espèce parmi les longicornes et qu'il faut y voir un passage à ces dernières.

À l'origine du groupe se placent, d'un côté le genre *Palinurellus*, qui a conservé le rostre large et très saillant des Homariens ; de l'autre les deux genres *Puerulus* et *Linuparus*, dont le céphalothorax présente les trois faces rectangulaires des *puerulus* ; les *Jasus*, où le rostre est encore bien développé, et les *Palinurus*, où il devient rudimentaire, occupent le sommet de la série.

Les *puerulus* correspondant aux trois premiers genres n'ont pas encore été découverts, mais on connaît ceux des deux espèces de *Jasus*, et j'ai trouvé le *puerulus* d'un *Palinurus* dans les matériaux recueillis par le " Blake."

PUERULUS DES JASUS.—Les *Jasus* habitent les mers australes, où ils comptent deux espèces : le *J. Lalandei* Lamarck, qui se trouve à Juan Fernandez, au Cap, à l'île St. Paul, et en Nouvelle-Zélande ; et le *J. Verreauxi* Edw., qui est localisé dans ces derniers parages. Deux sortes de *puerulus* ont été trouvées dans ces mêmes régions.

1°. *Puerulus* du *Jasus Lalandei*—L'une de ces formes a été décrite par M. GRUVEL (1911, 1911^a) comme le jeune du *J. Lalandei* d'après trois exemplaires déposés dans les collection du Muséum et qui proviennent de l'île St. Paul, où il furent pris par M.

VÉLAIN. La carapace de ces exemplaires est faiblement mais régulièrement convexe du côté dorsal, surtout au niveau des régions branchiales, où sa rencontre avec les flancs produit une arête fort nette qui s'atténue, puis disparaît dans la région postérieure. Le rostre est un peu infléchi, triangulaire, aigu ; les cornes frontales sont un peu convergentes et cachent l'articulation des pédoncules oculaires. Outre les deux paires d'épines frontales caractéristiques des *puerulus*, la carapace présente une épine gastrique et, de chaque côté, deux épines branchiales antérieures, l'une à l'extrémité même de l'arête dorso-latérale, l'autre située un peu plus en arrière et au voisinage de la région gastrique. On observe à l'état de rudiments une paire d'épines gastriques postérieures, deux paires successives d'épines cardiaques, et une rangée d'épines marginales postérieures ; ces rudiments se présentent sous la forme de saillies obtuses très peu visibles.

Les épines des pédoncules antennaires sont disposées comme celles de l'adulte et d'ailleurs en même nombre ; sur la face dorsale de l'article basilaire manquent toutefois une grosse épine et une spinule qui se développent vraisemblablement lorsque la forme définitive apparaît ; on peut faire des observations analogues sur les épines du telson et des uropodes. Comme chez l'adulte, les antennules dépassent à peine l'extrémité distale des pédoncules antennaires et l'exopodite réduit des maxillipèdes postérieurs atteint, au plus, la ligne d'articulation de l'ischio-podite avec le méropodite.

Abstraction faite de l'arête dorso-latérale, tous ces caractères permettent de rapporter les *puerulus* de St. Paul au *Jasus Lalandei*, qui est, d'ailleurs, le seul Palinuridé connu dans l'île.

2°. *Puerulus* du *Jasus Verreauxi*.—Si les *puerulus* de St. Paul représentent le stade natant du *Jasus Lalandei*, il faut certainement rapporter au *Jasus Verreauxi* les *puerulus* de l'île Stewart, que M. CALMAN a brièvement décrits et justement regardés comme les "natants" d'une espèce de *Jasus* (1909).

Ayant pu étudier ces exemplaires, grâce à l'obligeance de M. CALMAN, qui a bien voulu me les soumettre, j'ai constaté, en effet, qu'ils sont loin d'être identiques aux exemplaires de l'île St. Paul. Au lieu d'être régulièrement convexe du côté dorsal, leur carapace présente une dépression longitudinale sur les côtés de la région cardiaque et, en dehors de cette dépression,

une saillie longitudinale arrondie qui fait le passage des flancs au dos et remplace l'arête caractéristique des *puerulus* de l'île St. Paul. Les cornes frontales, au lieu de converger, sont plutôt un peu divergentes et laissent apparaître l'attache des pédoncules oculaires. Les épines rudimentaires de la carapace sont bien plus nombreuses et bien plus fortes que celles du *puerulus* de St. Paul ; on en voit une paire en arrière des épines annexées aux cornes frontales, deux paires sur la partie postérieure de la région gastrique, une série longitudinale de trois paires et deux paires plus en dehors sur la région cardiaque, enfin les épines marginales postérieures paraissent bien plus fortement indiquées. Les épines des pédoncules antennaires sont d'ordinaire un peu plus grandes et l'on en trouve deux de plus sur la face dorsale du deuxième article.

Ces différences ne sauraient être attribuées à l'âge, les exemplaires des deux sortes étant à peu près de même taille. Elles sont de nature spécifique et les *puerulus* de l'île Stewart ne sauraient être les "natants" du *Jasus Lalandei*, encore que cette espèce soit répandue vraisemblablement dans toute la région néo-zélandaise. Il faut sans doute les rapporter à l'autre espèce propre à ces régions, je veux dire au *Jasus Verreauxi*.

PUERULUS DES PALINURUS.—J'ai eu la bonne fortune de trouver une troisième sorte de *puerulus* brévicornes dans les matériaux recueillis aux Antilles par le regretté A. AGASSIZ durant l'expédition du "Blake." Elle est représentée par un individu capturé au voisinage de l'île Santa-Cruz.

Outre les saillies spiniformes propres à tous les *puerulus*, cet exemplaire présente un rudiment de rostre et trois carènes longitudinales, une cardiaque et deux branchiales. Le rudiment de rostre montre que nous avons affaire à un *Palinurus*, et comme on ne connaît aux Antilles que deux espèces de ce genre, le *P. longimanus* Edw. et le *P. truncatus* A. M. Edwards, la question est de savoir à laquelle de ces deux langoustes il convient de rapporter le *puerulus* d'AGASSIZ.

C'est à la première, on n'en saurait douter. Les cornes frontales sont munies de denticules sur leur bord supérieur et inermes sur le bord inférieur comme dans le *Palinurus longimanus*, les pédoncules antennaires présentent une armature épineuse identique (une épine sur la face dorsale du 1^{er} article,

7 sur le 2^e et le 3^e), les pédoncules antennulaires sont seulement un peu plus courts et les pattes antérieures, sans être aussi longues et aussi fortes que celles du *P. longimanus*, se distinguent déjà des suivantes par leurs dimensions. Cela ne rappelle en rien le *P. truncatus*, qui a des cornes frontales inermes en dessus et denticulées en dessous, des épines antennaires plus nombreuses et autrement disposées, des antennules beaucoup plus longues, des pattes antérieures tout à fait normales.

L'exopodite des maxillipèdes externes, dans le *puerulus* d'AGASSIZ, est semblable à celui du *P. longimanus*, c'est-à-dire aussi long que l'endopodite et nettement flagellé. À la naissance du telson, le 6^e segment abdominal présente de chaque côté un prolongement spiniforme qui se retrouve chez l'adulte, mais plus réduit. Je signale dans ce *puerulus* une paire d'épines situées en arrière, sur le sternum, à la base des pattes postérieures ; ces épines disparaissent chez l'adulte, elles n'existent pas dans les formes natantes du *Jasus*, mais se retrouvent, comme on le verra plus loin, chez la plupart des *puerulus* longicornes.

II. LES PUERULUS LONGICORNES.

Les *puerulus* de ce groupe répondent parfaitement à la définition des langoustes longicornes telle que l'a donnée MILNE-EDWARDS (1837) : " Il n'existe sur le bord antérieur de la carapace aucun vestige de rostre médian ; l'arceau antennulaire est très large et presque carré, de manière à écarter beaucoup entre elles les antennes externes et à laisser à découvert les antennes internes ; enfin, ces derniers organes se terminent par deux tigelles multiarticulées très longues." Il convient d'ajouter que l'arceau antennulaire des longicornes présente toujours une armature épineuse et que les fouets de leurs antennules, peu différents l'un de l'autre et filiformes, sont aussi longs ou plus longs que les pédoncules, par conséquent aussi éloignés que possible du type homarien.

Ainsi défini, le groupe des longicornes se limite au seul genre *Panulirus* qui comprend à lui seul plus d'espèces que la totalité des autres Palinuridés : 12 espèces contre 8 d'après la monographie récente de M. GRUVEL. Comme je l'ai dit plus haut, le

genre *Puerulus* se rapproche des longicornes par le grand développement transversal de l'arceau antennulaire.

On connaît cinq espèces de *puerulus* longicornes ; outre les épines et les cornes frontales caractéristiques du stade " natant," elles présentent presque toujours trois carènes longitudinales comme le *puerulus* d'AGASSIZ et, sur la partie antérieure des carènes latérales, une épine branchiale plus ou moins développée.

1°. *Puerulus pellucidus*.—De ces quatre espèces, la plus voisine des brévicornes est le *puerulus pellucidus* ORTMANN (1891), des mers du Japon. À l'inverse des autres *puerulus* longicornes, ce crustacé manque totalement d'épines sternales et présente sur les maxillipèdes externes un exopodite bien développé, quoique réduit à deux articles.

A quelle espèce japonaise faut-il rapporter ce *puerulus*? au *Panulirus japonicus* Siebold ou au *Pan. Burgeri* de Haan? Probablement à la première de ces espèces, qui porte sur les maxillipèdes externes un exopodite bien développé alors que la seconde en est dépourvue. Mais je ne saurais insister, n'ayant pas vu l'exemplaire de M. ORTMANN.

2°. *Puerulus spiniger* (stade " natant " du *Panulirus ornatus*).—Je n'insisterai pas davantage sur le *puerulus spiniger* ORTMANN (1894), M. CALMAN ayant fort bien établi que cette forme représente le stade " natant " du *Pan. ornatus* Fabr. (*Pan. versicolor* Latr.).

Les exemplaires de M. ORTMANN ont été recueillis à Amboine par le Professeur RICHARD SEMON et ceux de M. CALMAN aux îles Christmas par le Dr. C. W. ANDREWS. Ces derniers mesurent environ 25 mm. de longueur et, comme ceux d'Amboine, furent trouvés en compagnie de jeunes *Panulirus ornatus*, dont la taille était à très peu près la même. M. BOAS (1880) avait constaté déjà que les dimensions des très jeunes langoustes sont sensiblement les mêmes que celles des *puerulus*.

3°. *Puerulus* du *Panulirus dasyphus*.—Une observation semblable peut être faite au sujet de trois *puerulus* et de trois jeunes langoustes recueillis dans la Mer Rouge par M. le Dr. JOUSSEAUME qui les donna au Muséum : les *puerulus* mesurent de 15 à 19 mm. et les jeunes langoustes de 18 à 20.

Dans sa belle étude sur la " Faune carcinologique de la Mer Rouge," le regretté NOBILI a rapporté ces *puerulus* au *spiniger* d'ORTMANN, non sans observer toutefois que leurs crêtes latérales

présentent “deux épines au lieu d’une seule”; et quant aux jeunes langoustes, il les signala comme *Panulirus*, mais sans pousser jusqu’à leur détermination spécifique (1906).

Or, il m’a été facile de constater que les trois jeunes langoustes présentent tous les caractères du *Panulirus dasyptus* Latr., entre autres les crénelures et la faible interruption médiane des sillons transverses abdominaux. Et d’autre part, les *puerulus* de M. JOUSSEAUME se distinguent du *spiniger*, non seulement par la présence de deux épines antérieures (au lieu d’une seule) sur les carènes latérales, mais par le développement d’un faible bourgeon exopodial à la base des maxillipèdes externes, et par l’état presque rudimentaire de l’épine située à l’angle antéro-interne sur le 2^e article des pédoncules antennaires. Si l’on observe que cette épine devient très volumineuse dans le *Panulirus ornatus* au lieu de rester médiocre comme dans le *P. dasyptus*,— que la première de ces espèces peut atteindre une fort grande taille, tandis que la seconde est plus réduite, on devra conclure de ce qui précède que le *puerulus* de M. JOUSSEAUME ne peut être identifié avec le *spiniger* et qu’il représente, suivant toute vraisemblance, le stade “natant” du *Panulirus dasyptus*.

4°. *Puerulus de l’Atlantique*: *puerulus inermis* et *puerulus atlanticus*.—On connaît également des *puerulus* longicornes dans l’Atlantique tropical et subtropical: le premier fut décrit par M. POCOCK (1890) sous le nom de *Panulirus inermis*, et la “Princesse Alice” en a découvert un autre que j’ai appelé (1905) *Puer atlanticus*. Le *puerulus inermis* est actuellement représenté dans les collections par l’exemplaire type qui provient de Fernando Noronha, c’est-à-dire des eaux brésiliennes. Le *puerulus atlanticus* habite, au contraire, l’Atlantique oriental. On en possède trois spécimens: l’individu type capturé au voisinage de S^{te} Lucie, dans les îles du Cap Vert, et deux autres pris à Kotonou par M. de CUVERVILLE, qui les donna au Muséum; ces derniers se trouvaient en compagnie d’un jeune *Panulirus regius* Brito Capello à peu près de même taille.¹

Les deux formes sont très voisines et se distinguent l’une et

¹ J’avais considéré ce jeune comme un *Panulirus guttatus* (1905), mais M. GRUVEL a rectifié cette détermination (1911) et établi que le *P. guttatus* appartient aux régions atlantiques occidentales tandis que le *P. regius* est localisé dans l’Atlantique africain.

l'autre du *puerulus* de JOUSSEAUME par la présence d'une seule épine au lieu de deux à l'extrémité antérieure de chaque région branchiale. S'appuyant sur la trop brève diagnose par laquelle j'avais caractérisé le *puerulus atlanticus*, M. CALMAN (1909) envisage comme très probable l'identité des deux formes, mais cette supposition me paraît sujette à critiques.

En effet, dans sa longue et très précise description du *puerulus inermis*, M. Pocock passe complètement sous silence les carènes latérales qui sont, par contre, fort bien développées dans le *puerulus atlanticus*; et d'autre part, la carène médiane du *puerulus inermis* serait très obtuse ("very obtuse"), alors qu'elle est aiguë et presque tranchante dans l'*atlanticus*. Je crois bien qu'il existe aussi des différences dans l'armature des pédoncules antennaires, notamment dans celle de l'article terminal, qui, d'après M. Pocock, porterait dorsalement 10 épines chez l'*inermis*, alors que ce nombre est réduit à 9 dans l'*atlanticus*. Et sans doute pourrait-on relever d'autres caractères distinctifs si les deux formes étaient en présence; il serait intéressant de savoir, par exemple, si le *puerulus inermis*, à l'exemple de l'*atlanticus*, présente un court bourgeon exopodial à la base des maxillipèdes externes.

La conclusion probable c'est que les deux espèces de *puerulus* sont parfaitement distinctes. Le *puerulus inermis* représente le stade "natant" d'un des trois *Panulirus* de l'Atlantique américain, *guttatus* Latr., *argus* Latr., *laevicauda* Latr., peut-être même de la dernière espèce, qui fut trouvée aussi, d'après M. Pocock, à Fernando Noronha. Et quant au *puerulus atlanticus*, il se rapporte sûrement au *Panulirus regius*, qui représente à elle seule le genre *Panulirus* dans l'Atlantique africain. Cette identification ne saurait être douteuse; M. GRUVEL l'a établie par la comparaison de matériaux nombreux et je ne puis que la confirmer.

Je crois utile de relever, dans le tableau suivant, les caractères essentiels des divers *puerulus* et le nom du Palinuridé auquel chacun d'eux se rapporte. La place qu'y occupent les *puerulus spiniger* et *inermis* ne saurait être considérée comme définitive parce qu'elle résulte simplement de la description des deux espèces; pour la rendre stable et précise il sera nécessaire d'établir une comparaison directe entre les deux formes et le *puerulus atlanticus*, qui en est certainement très voisin.

Brévicornes.

Fouets antennulaires fort dissemblables et plus courts que les deux derniers articles pédonculaires réunis ; arceau antennulaire beaucoup plus long que large.

- | | | |
|--|---|---|
| Pas de carène cardiaque ;
rostre assez bien développé ; exopodite des
maxillipèdes externes
réduit à une courte
tige et sans fouet ; pas
d'épines sternales | { | Cornes frontales un
peu convergentes,
dos régulièrement
convexe 1. Puerulus de VÉLAIN (du
<i>Jasus Lalandei</i>).

Cornes frontales non
convergentes, dos
longitudinalement
déprimé sur chaque
côté de la région
cardiaque 2. Puerulus de CALMAN
(du <i>Jasus Verreauxi</i>). |
|--|---|---|

- | | | |
|--|---|---|
| Trois carènes longitudinales (une cardiaque et
deux branchiales) ; rostre rudimentaire ;
exopodite des maxillipèdes externes bien
développé et flagellé ; une paire d'épines
sternales | { | 3. Puerulus d'AGASSIZ (du
<i>Palinurus longimanus</i>). |
|--|---|---|

Longicornes.

Fouets antennulaires peu dissemblables, aussi longs ou plus longs que les pédoncules ; arceau antennulaire large ; pas de rostre.

- | | | | | | | | |
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| Pas d'épines sternales ; trois carènes longitu-
dinales, sur la carapace ; exopodite des maxilli-
pèdes externes de deux articles | { | 4. Puerulus pellucidus (du
<i>Panulirus japonicus</i> ?).

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SEAUME (du <i>Panulirus
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de chaque carène
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<i>Panulirus regitus</i>).

 7. Puerulus spiniger (du
<i>Panulirus ornatus</i>).

 Pas de carènes branchiales, carène
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Où faut-il ranger les exemplaires étudiés par M. BOAS dans l'admirable travail où il a fait connaître l'existence d'un stade "natant" chez les Palinuridés ? Ils appartiennent, dit-il, "à plusieurs espèces, la unes longicornes, les autres brévicornes," et "une partie d'entre eux au moins furent capturés au large." Dans quelles mers ? M. BOAS ne le dit pas, et sans doute l'ignorait-il. Si quelques-uns de ces exemplaires avaient été pris dans les mers européennes, ils représenteraient, à coup sûr, le stade natant de notre langouste, qui, chose extraordinaire, reste complètement inconnu. J'ai demandé à Copenhague les *puerulus* étudiés jadis par M. BOAS, mais ils ont été soumis à un autre zoologiste et je n'ai pu en tirer parti pour la rédaction de cette note.

Les *puerulus* sont très rares dans les collections, mais les jeunes langoustes de petite taille rivalisent avec eux sous ce rapport, et l'on peut croire que les uns et les autres habitent les mêmes eaux, d'autant que les deux formes se trouvent parfois associées dans une même pêche. M. BOAS dit que certains *puerulus* du Musée de Copenhague "furent capturés au large," mais sans préciser la profondeur. Celle-ci, probablement, n'était pas fort grande, et je crois bien que les *puerulus* habitent à très peu près les mêmes milieux que leurs adultes ; le type du *puerulus atlanticus* fut trouvé aux îles du Cap Vert par 20 mètres de profondeur, et le *puerulus* de M. JOUSSEAUME dans les crevasses du rivage comme d'ailleurs, d'après M. CALMAN, le *puerulus spiniger* du *Panulirus ornatus*. Ces renseignements pourront servir à des recherches ultérieures.

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SOBRE ALGUNAS ANOMALÍAS EN LAS ALAS DE
LOS HIMENÓPTEROS (EL GÉN. *NOMADITA* MOCS.
Y EL GÉN. *BIAREOLINA* DOURS.).

POR EL DR. J. M^a. DUSMET, MADRID.

LAS alas de los himenópteros ofrecen con relativa frecuencia anomalías, que consisten, unas veces en la desaparición total ó parcial de alguna de las venas normales y otras veces, por el contrario, en la existencia de alguna vena adventicia ó extraordinaria. Tengo en preparación un estudio sobre casos diversos de estas modificaciones en individuos de varias familias, pero creo interesante anticipar, en este pequeño trabajo, dos observaciones que manifiestan la facilidad con que las citadas anomalías pueden inducir á errores, aun á entomólogos eminentes.

En 1894 describió el ilustre ALEX. MOCSARY (*Természeti Füzetek.*, vol. xvii.) el género nuevo *Nomadita*, cuyos caracteres distintivos concuerdan todos con los del género *Nomada*, Panz., excepto en que tiene dos celdillas cubitales, puesto que, aunque el autor dice que se distingue también por la vena ordinaria intersticial en las alas anteriores, sabido es que esto mismo ocurre, no en la mayor parte, pero sí en algunas especies de *Nomada*.

Funda MOCSARY el gén. *Nomadita* con la especie *N. montana*, sobre un solo ejemplar ♂, cazado en Julio a 3,000 piés de altura, en Hungría septentrional.

En un trabajo sobre las *Nomada* de España, que he de dar muy pronto á la imprenta, aparecerá, entre otras, una especie nueva, la *Nomada ferroviaria* Dism., de la cual he cazado en los alrededores de Madrid un total de 22 ejemplares, de ellos 17 (5 ♀ 11 ♂) en un mismo día y sitio (Montarco, 17 Mayo. Taludes de la vía férrea). Todas las ♀ y 9 de los ♂ tienen las tres celdillas cubitales normales. En un ♂, la 2ª vena transverso-cubital, en ambas alas, existe solo en parte, ó sea en su mitad inferior, habiendo desaparecido en la superior. En otro

♂ falta por completo dicha 2ª vena en ambas alas, sin que quede el menor vestigio de ella, de modo que existen solamente 2 celdillas cubitales. Estas son exactamente como expresa MOCSARY en la característica de su género *Nomadita*: "*Alæ superiores cellulis cubitalibus completis duabus, magnitudine subæqualibus, secunda cubitali ambos nervos recurrentes excipiente nervo recurrente primo ante medium, secundo ab apice sat remote terminatis.*" Entre los otros 6 ejemplares de *N. ferroviaria*, de distintas localidades, hay una ♀ en la que desaparecen también por completo las 2ªs venas transversocubitales.

Resulta, pues, indudable que el ♂ ó la ♀ con 2 celdillas cubitales, si hubiesen sido cazados aisladamente habrían pertenecido al gén. *Nomadita* y sin embargo, son verdaderas *Nomada*, puesto que las 17 de Montarco, cazadas á un tiempo, son iguales por todos sus restantes caracteres y hay, además, entre ellas, otro ejemplar que marca la transición, iniciándose el paso de 2 á 3 celdillas.

Es, por lo tanto, evidente que *Nomadita montana* será, ó una nueva especie de *Nomada*, ó, más probablemente, un ejemplar anómalo de alguna especie ya conocida, lo cual solamente á la vista del tipo podría resolverse, pues son varias las especies de 6 mm. y abdomen rojo, pareciendo, por la descripción, que debe ser próxima á la *N. furva* Panz.

Debe advertirse que DALLA TORRE en su *Catalogus Hymenopterorum*, considera *Nomadita* sinónimo de *Nomada*, aunque sin citar ningun autor que lo haya asi establecido.

Acabamos de ver que en el gén. *Nomada*, de 3 celdillas cubitales, se hallan en algunas especies individuos con solo 2 celdillas, ó con la iniciación de esta anomalía, dando motivo á que se funde el género *Nomadita* sobre uno de dichos ejemplares. Ahora nos ocuparemos de otro ejemplo algo diferente. Aquí es toda una especie la que experimenta la modificación, convirtiéndose en constante la anomalía y haciendo que aparezca, por el número de sus celdillas, separada del género á que por todos sus demás caracteres debe pertenecer, mientras que algunos individuos, siendo anómalos dentro de su especie, muestran aún más clara la unión de ésta á las restantes de su género natural.

Me refiero al gén. *Biarcolina* Dours. (o Dufour.), cuya descripción original no conozco. Está formado por una sola especie,

la *B. neglecta* Dours., puesto que la *B. Perézella* Dours., según el notable entomólogo de Burdeos J. PEREZ me comunicó (*i. litt.*) debe ser considerada como variedad.

La *Biareolina* tiene 2 celdillas cubitales, perteneciendo por todos sus demás caracteres al gén. *Andrena*, Fabr., tan abundante en especies paleárticas y que, como es sabido, tiene 3 celdillas cubitales. DALLA TORRE considera *Biareolina* como sinónimo de *Andrena*. PEREZ, SCHMIEDEKNECHT, y GAULLE lo respetan como género independiente.

La *B. neglecta* se halla, según DALLA TORRE, en la Europa central y meridional y en Argelia; es muy abundante en Burdeos (PEREZ) y se halla en bastantes localidades de Cataluña (BOFILL). Es probable que se halle muy esparcida por España, pero, por su época muy temprana de vida, no la he cazado más que en Madrid. En estos alrededores es abundantísima durante el mes de Marzo, pululando sobre las Crucíferas y otras flores, pudiendo cogerse algunos centenares en cualquier día de excursión.

Tengo ahora á la vista unos 160 ejemplares, que tienen sus alas normales, excepto dos de ellos. El primero, que presenta en el ala izquierda las dos celdillas cubitales, en el ala derecha tiene tres, por haberse formado una pequeña, intermedia, á expensas de la 2ª, ó sea mediante una vena transverso-cubital extraordinaria, que se inserta más atrás de la 1ª vena recurrente. Resultan, por tanto, tres celdillas completamente semejantes á las de las *Andrena*, ó sea la 1ª mayor que la 3ª y la 2ª mucho menor que las otras. Este ejemplar es una ♀. El otro es un ♂ que tiene el ala derecha con 3 cubitales, como la ♀, pero el ala izquierda muestra la transición, pues la vena extraordinaria solo existe en su mitad inferior, sin cerrarse del todo la pequeña celdilla intermedia.

Bien claro se manifiesta de este modo que la *Biareolina* es una verdadera *Andrena*, en la cual, por causas cuya investigación exigiria un trabajo más profundo, las alas anteriores han suprimido una vena transverso-cubital.

Deben ser muy abundantes los casos semejantes á los dos citados y tengo el propósito de continuar su estudio, que creo interesante, tanto con respecto á la Filogenia, para establecer las relaciones de unos géneros con otros, como respecto á la Sistemática, para evitar dudas ó errores de clasificación.

RESOLUTION OF THE ENTOMOLOGICAL SOCIETY OF LONDON.

Moved by G. T. BETHUNE-BAKER, F.L.S., F.Z.S.

ON behalf of the Entomological Society of London, I beg to move the following resolution:—

“ The present independent and irresponsible methods of giving and adopting names having resulted in much unnecessary synonymy, and even graver abuses, the Entomological Society of London feels that the time has arrived when some check should be placed upon the practice of more weight than that which can be exercised by any single individual, society, or publication, and would urge upon the International Congress the establishment of a permanent International Committee to deal with questions of nomenclature as affecting Entomology; to consider what elucidations, extensions, or emendations, if any, are required in the International Code; and to confer with the International Commission of Zoological Nomenclature. The Entomological Society of London recommends that the International Entomological Committee, when formed, shall take such action as to ensure the adequate representation of Entomology on the International Zoological Commission. The Society also recommends that, considering the difficulty of frequent International meetings, the leading Entomological Society of each country be invited to appoint a Committee whose duty it shall be to deal with all questions arising in their own country, subject to reference to the International Committee; and suggests that the International Committee be composed of two or three members of each of the National Committees, elected either by the Committees, or directly by the electing societies.”

This question—having disturbed the minds of many entomologists here—was brought to a head by the publication of a paper in the *Entomologist's Monthly Magazine* for February 1912, by MEYRICK, in which he published a list of no less than

ninety-four new names as substitutes for a long series of new species described by KEARFOTT in 1907, and published in the *Trans. American Ent. Soc.*, vol. 33 (1907), and in the *Canadian Entomologist* for the same year; he also included three names of BUSCK'S. The matter was discussed very fully at two meetings of the Entomological Society of London, who appointed a sub-committee to consider the whole question and to report, and after the report the resolution I have moved was carried practically unanimously. Without considering the propriety of MEYRICK'S substitutions, it was strongly felt that KEARFOTT'S names were untenable, primarily for the reason that to the ordinary person they are quite unmemorable. It would not be possible for the ordinary worker to memorise ninety plays on the syllable "*ana*," without very serious effort and constant reference to the originals; in addition to this there are names such as *Enarmonia vana* and *wana*; *Eucosma sandana*, *xandana*, *zandana*, *vandana*, *wandana*; *Phalonia foxana*, *voxana*; *Eucosma vomonana* and *womonana*, and others somewhat similar. The sound of *Eucosma sandana*, spelt with an *s*, *x*, or *z*, is absolutely indistinguishable in English and other languages, those beginning with *v* and *w* are indistinguishable in some languages, and it was felt some steps ought to be taken to prevent the recurrence of such a list of names. Besides these, KIRKALDY published a series of what many consider objectionable names, such as *ochisme* (oh kiss me) *isachisme* (I say kiss me), *florichisme* (Florry kiss me) *dolichisme* (Dolly kiss me), and many others similar to these—I may say that there is ground for believing that the bracketed explanations are the origins of all these appellations, and it was considered that such names could only bring Entomological science into disrepute, if they did not make it a laughing-stock to the scientific world. The resolution I have moved does not in any way conflict with those already passed at the first Congress. It will be seen that there is no desire to oppose the International Commission of Zoological Nomenclature, but rather a desire to strengthen their hands and to prevent, if possible, that Commission from departing from their own Code. I speak as an upholder of the Code, but I want it improved. It consists of rules and recommendations, the former of which are binding, but the latter are not. I would like to eliminate many of the

latter, and to make some new rules, but above my own desires it is really necessary for the Commission to adhere to their own rules, if the scientific world is to follow their lead. This, unfortunately, they do not do. For instance, Art. 25, The Law of Priority, runs as follows: "The valid name of a genus or species can be only that name under which it was first designated, on the condition: (a) That this name was published and accompanied by an indication, or a definition, or a description; and (b) that the author has applied the principles of binary nomenclature." I would ask the members of the Congress to remember *b*. With this law before them the question of MEIGEN'S genera of 1800 came under their view, when instead of settling the question absolutely, as it is really settled by Art. 25*b*, the Secretary of the Commission sent a letter to the members of the Commission, asking whether the *Nouvelle Classification* of MEIGEN of 1800 should be given precedence over his *Versuch* of 1803, and the decision was that precedence should be given where valid. I submit, sir, that that decision is contrary to Art. 25. MEIGEN'S 1800 classification is absolutely uninominal, and is, therefore, entirely contrary to section *b*, and consequently cannot be accepted. According to the Code MEIGEN'S names can only be accepted from the date when the author applied the principles of binary nomenclature, *i.e.* 1803. This decision of the Commission is therefore entirely contrary to the Code and cannot be accepted until Art. 25 is altered. At the present time there is a somewhat widespread movement to restrict the Law of Priority. This is not altogether unnatural from one point of view, but from the point of view of the systematist I sincerely hope it will not be done. It is not unnatural for the pure biologist and general zoologist to desire to retain names that he remembers from his student days; the question, however, that I would ask is, Is it scientific? I am not unmindful of the fact that there are many Professors, especially in America and Germany, who object to the Law of Priority, partly, no doubt, on the ground that their text-books have adopted certain more or less well-known names, but this difficulty is really small, when it is remembered that reprints of all important text-books are being constantly put through the press, and it would be a very simple matter to insert the correct names according to the Law of Priority, when they are brought to light, and

to let the name in current use by the teaching profession follow in brackets. This could be no real hardship to any one, and it might possibly meet the objections of the learned professors who do not happen to be specialists in particular branches of natural history. All sections of workers should remember that the Code was formed in order to obtain a stable nomenclature, and that it is steadily working in that direction, but the end cannot be obtained in a decade. Nature works slowly, and we should do well to follow her example. We have to deal with a vast amount of literature, extending over one hundred and fifty years, and it is only as the systematist, in his monographs or other work, investigates this mass of literature, that stability will be obtained, for it should be borne in mind that it is the systematist who must be in the end the final court of appeal, at least in the elucidation of species, and therefore in the elucidation of the names of species.

It is said that changes of names bother those who are not specialists, but I have little doubt that the suggestion of "nomina conservanda" in combination with the Law of Priority would be infinitely more perplexing, whilst it would be an open door for endless changes. The fact that the number of species and genera in Entomology far outweighs the number of living forms that belong to the whole of the other classes of the animal kingdom is ample justification for the considerable extension of the powers and status of the Committee formed at our first International Congress as suggested by my resolution, and I trust that this second Congress will approve of the resolution of the Entomological Society of London that I have had the honour of moving.

SUGGESTIONS FOR SECURING SIMPLIFICATION AND PERMANENCY IN NOMENCLATURE.

BY GEORGE WHEELER, M.A., F.Z.S., HON. SEC. E.S.

As a member of the committee that drew up the resolution to be submitted to this Congress by the Entomological Society of London, it is perhaps unnecessary for me to record my hearty agreement with that resolution as far as it goes. It was, however, during the deliberations of that Committee that I became more and more deeply impressed with my previous conviction, that so long as the advocates of "Priority at any price" remain masters of the field, any hope of unanimity or of fixity of nomenclature—the goal at which they are supposed to aim—is amongst the most impossible of utopian dreams. The members of that Committee, representing the most widely divergent views on the subject, were all nominally in favour of the Law of Priority in some form, but it soon became apparent that almost all had in reserve a list—sometimes rather a long list and always a different one—of exceptions, to which that law ought not, in their opinion, to apply. So much for unanimity, and the dream of fixity is as wild; for at any time a forgotten book, or magazine, or pamphlet, may turn up in some out-of-the-way or unexpected corner, to upset not only well-established and universally accepted names, but the whole systematic work of those who have regarded these names as affording an unchangeable basis. I need only refer in passing to MEIGEN'S paper on Diptera, dated 1800, and only recently discovered, which has been so precipitately accepted in some quarters, apparently without any necessity; but if the advocates of "Priority at any cost" are to have their way, something almost amounting to a catastrophe is impending over unhappy Lepidopterists, for the whole systematic structure founded on the supposition that the Papilionid stirps is permanently referable to the "Swallow-tails" will fall

to the ground when it is realised that SCHRANK in his *Fauna Boica*, in 1801, made *antiopa* the type of the genus *Papilio*. Of this fact SCUDDER was aware, but to his eternal credit he continued to employ the term in accordance with immemorial usage. It is obvious that so long as such subversions are possible, no systematic work can be regarded as permanent, and thus, not only is fixity of nomenclature made impossible, but the work of the systematist is rendered discouraging, and is apt to become half-hearted, and sometimes perhaps careless and incorrect. Not that I have any wish to exaggerate the importance of the systematist. I always feel that we (if I may dare to count myself among them) perform for science the useful, but humble, functions of the housemaid; for much of our time is spent in laboriously tidying up the litter and confusion that other people have made, whether through the inevitable force of circumstances, or through their own carelessness or laziness, and in thus clearing a space in which the more showy and more permanent, and perhaps also more important, forms of work may be done. Still, even this is a point which cannot be passed over in absolute silence, for anything which is likely to affect the quality of necessary work is not without a certain importance.

But it may be argued that names which can be traced back to the tenth edition of LINNEUS are at any rate fixed and permanent. Granting that this were so, the number of species affected would be comparatively small, but even this is not universally true. It is sometimes discovered that we have been using a Linnean name for many decades in a different sense from that which LINNEUS intended, and years of confusion result. I will only refer to the notorious instance of the *Lycænid argus*, but it is far from being an isolated case. I have heard it argued that to retain such a name for the species to which it had been for more than half a century universally applied, would involve a sacrifice of truth; I confess that this argument leaves me absolutely unmoved, but may add that no sacrifice of truth, or of anything else except confusion, would be involved if for the future the species were known as "*argus auctorum*," instead of "*argus* Linneus." The fundamental misconception which is at the root of all such objections, and even more obviously so in the case of emendations, is that there

is some credit accruing to the author of a name from the fact that he has given it. That there is a responsibility attached to the action may be readily admitted, but so far from its being necessarily creditable, a name may merely stand as a monument of an author's ignorance, or conceit, or stupidity, or again, without being actually discreditable, of his harmless eccentricity only. It has been cynically remarked that "any fool can give a name." Quite so, but why should those who are not fools be compelled to accept it?

Still, it is, I suppose, universally admitted that Priority must be the foundation-stone of nomenclature, as well as of classification, which is not necessarily the same thing; and the wide differences of opinion that exist are concerned, not with this foundation, but with the question of what exceptions, if any, should be admitted; and it is only against "Priority at any price," not against Priority as a general principle, that I wish to contend. There is probably no one who would not assent to the Law of Priority in the sense that the oldest available name of a species, variety, etc., is the correct name: the whole question at issue turns on the definition of the two words "name" and "available," for not every pronounceable combination of letters is a "name," nor should every name, not pre-occupied, be regarded as "available." To this point I shall shortly recur.

I observed that nomenclature is not necessarily the same thing as classification, but this is strictly true of one form of nomenclature only—in my opinion the ideal form—that is, of a uninomial nomenclature. Everybody, according to the language he speaks, understands what you mean when you talk of the "Red Admiral," or the "Trauermantel," or the "Paon du jour," and these names are all uninomial, though they consist of one, two, and three words respectively; but in the absence of a universally accepted language this ideal seems hopeless of realisation. It *need* not have been so, if the same Latin name had never been regarded as available for more than one species, for then the word would have designated that one thing, and, zoologically speaking, would have meant nothing else, and would therefore have been an ideal name, the chief reason for giving a name at all being that the object named may be recognisable

without a description. The moment, however, that we get beyond a uninomial nomenclature, and group species together under a common term, we step into the region of classification, however rudimentary, for classification consists of such grouping of species, though the details always tend to become more and more complicated as our knowledge extends. It has been suggested that the first name by which a species was described, generic and specific, should be its permanent *name*, however it may afterwards be classified; but this plan would surely make classification and nomenclature not merely unconnected, but directly antagonistic, and would be the fruitful parent of confusion and entanglements many times worse than those which it was designed to avoid. Is it, however, too late to go back, for purposes of nomenclature only, to the Linnean terminology, calling all Butterflies *Papilio*, all Hawk-moths *Sphinx*, and so on through the other orders? Some changes would doubtless be involved, but only such as ought never to have been necessary at all, for nothing more would be needed than slightly to extend the universally-accepted regulation that the same specific name must not be applied to two species in the same genus, by carrying back the idea of genus, in the sense of the division next above species, to its original inception, instead of leaving it, as it is at present, a constantly varying and ever more variable quantity. Indeed, in this matter I do not see where else a line can be drawn. At present, if I speak of a species as *Melitæa cynthia*, it means a definite thing, and if I discovered another species connected with even the most remote group of the genus, I should not be at liberty to name it also *cynthia*; but if I found it necessary—as is highly probable—to divide the genus into three, I should be free (if I were possessed by a demon of mischief) to call a newly-discovered species in one of the other genera *cynthia*, to the hopeless confusion of all lepidopterists who had not made a special study of the group; and this confusion would be increased by the fact that the original *cynthia* would no longer be in the genus *Melitæa* at all, which would of necessity be restricted to the group containing *cinxia*. What could be more ridiculous or more futile? Better ten thousand times to lay down a rule once for all, that no two species in the same Linnean division can have the same name, and that a

name already used in one modern genus is not available for another species in the same Linnean division, to however remote a modern genus it may belong. There you have permanency instead of constant fluctuation, and the chief, indeed the only obstacle to the virtual separation of nomenclature and classification is removed ; and that, too, on a plan which would produce neither antagonism nor confusion between them. In such a case as I have suggested by way of illustration, the species in question would be, for purposes of nomenclature, and would always remain, *Papilio cynthia*, and the name *cynthia* would not be available for any other butterfly whatever, since any such would, for the same purposes, be *Papilio cynthia* as well, whether classified as *Lycæna*, or *Pseudacræa*, or *Hesperia*, or what not. Even such confusion as may now exist between the Pierid *damone* and the Lycænid of the same name would cease, since the name would not be available in the latter instance, and HERRICH-SCHÄFFER'S name *damocles* would (as it should) take its place.

I must beg those entomologists whose studies have been chiefly in other orders to forgive my taking my illustrations mostly from the Lepidoptera, and from that part of the order with which I am best acquainted, but I am fully aware that all the inconveniences of which I complain are felt, in some cases with far greater force, in the other orders as well.

I remarked just now that not every pronounceable combination of letters is a name, and for this reason, that it may fail in the very first requisite for a name, that of ensuring the recognition of the object to which it is applied ; and this may further happen in the case of a word, unexceptionable in itself, in consequence of its too close resemblance to another already in use. What, then, is to be said of those strings of names that have of late years been applied among the Tortrices, such series I mean as *bana*, *cana*, *dana*, and so forth ? Certainly they do not fulfil the first requirements of a name, and I know I am voicing the determination of the vast majority of English entomologists, at any rate, when I say that we decline unconditionally to recognise them as names at all. Speaking for myself I would go much farther. I should like to see the rejection of all nonsense names whatever, on the ground that they are not really names at all,

and though I know that such a course is retrospectively impracticable, yet it might well for the future be "considered ethical" (to quote the authors of the *International Code*) to give a reasonable meaning for a new name at the time of bestowing it, unless indeed both the reason and the meaning were, as they often are, sufficiently obvious.

But this is not the only circumstance under which a pronounceable combination of letters may fail to be a name. Latin is the recognised medium of zoological and botanical nomenclature, and words, to be names, should conform both in form and spelling to classical usage. This is especially true of classical names, whose orthography is fixed and certain, for with regard to modern surnames the only possible method which can make for permanency is to adhere absolutely to the original spelling. I cannot refrain at this point from entering a protest against the custom sometimes adopted of substituting "v" for "w," and "c" for "k," in such proper names. The reason for such substitution it seems impossible even to guess. *Villiamsoni* is no more Latin than *Williamsoni*; it would no doubt be possible in this particular case to employ the somewhat barbaric form *Gulielmidæ*, but in most instances no such translation would be available; and what about the essentially English combination "wh"? "Vh" would not merely not be Latin, but would be utterly unpronounceable besides. On this last point, at any rate, I may be allowed an opinion, as it almost amounts to a personal matter. With regard to the substitution of "c" for "k," there is not even the excuse of a supposed latinity. "K" is as good a Latin letter as "a" or "b." The Romans had but eighteen prenomina at their disposal for their sons, each of which had its recognised abbreviation, and for one of these the letter "K" stood. It was, moreover, and still is, impossible to write the date of more than half the days in the year in Latin without employing this letter, and I cannot conceive of any stronger claim to a place in the Latin alphabet than is constituted by these two facts.

And this brings me to the delicate subject of emendations in the form and spelling of names actually in use. I am fully aware that I am treading on dangerous ground, but I intend, notwithstanding, to put my foot down firmly upon it, and to

assure those who adopt the "*non possumus*" attitude that there is not the remotest chance of peace until they abandon it. I believe I have read all, or nearly all, that has been written on the other side, and my profound respect, and in some cases personal friendship, for the writers must not prevent my characterising it as special pleading, sometimes very ingenious, and often delightful to read, but singularly unconvincing to any one not predetermined to be convinced. "Why" (as the President of the Entomological Society of London pertinently asked on a recent occasion) "should educated people be condemned to the perpetual use of barbarisms, merely because the original authors of names didn't know what they were talking about?" and why, I should like to add, should not these monuments of ignorance be allowed to be set right, even if only out of respect for the authors themselves? By all means let the original author get the credit (whatever it is) of the emended name; those who refuse to endorse these barbarisms with pen or tongue would be the last to grudge him that poor honour, and would feel it a very small price to pay for the happiness of being rid of them for ever. The general adoption of the Rules of the "Merton" Code on this subject appears to me to afford the only prospect of peace or permanence. It should also be borne in mind that the principle of the permissibility of emendation in orthography was fully recognised by the first International Congress of Entomology, and if emendation is permissible in this particular, it is difficult to see why it is not equally permissible in the matter of words incorrectly formed or fitted with a wrong termination. Specific names formed from the names of places should be made to end in *ensis*, those taken from the surnames of persons should be in the genitive, and it would be appropriate if in the case of ladies the genitive assumed a feminine form: for instance, *Plebeius nicholli* was named after its discoverer, the well-known lepidopterist, Mrs. Nicholl—the compliment would have been more obvious had it been named *Plebeius nichollæ*. When Christian names are employed the case seems somewhat different. "Alicia" or "Emilia," in the nominative, seem as permissible as "Phœbe" or "Iris."

Two other cases have been suggested in which perfectly legitimate and pronounceable names might have to be regarded

as "*nomina nuda*," and against both these suggestions I wish strongly to protest; they are, first, the case in which a figure is unaccompanied by a description, and secondly, that in which a description is unaccompanied by a figure. With regard to both these points, they seem to me condemned in advance as being much too wide in their application. At most, each case should be judged on its own merits, and names should not be rejected on either ground unless it is impossible to determine, either from internal or external sources, what species is intended. Hübner's figures, for instance, even when unaccompanied by letterpress, are generally unmistakable, whilst Bergsträsser's, letterpress and all, are often difficult, sometimes hopeless, to determine. The view of the former Congress, that it is "highly desirable" that descriptions should be accompanied by a figure, surely goes quite as far as is advisable in this direction. For in fact a figure, even a figure good in itself, may only serve to darken counsel. As an instance I may cite Moore's figure and description of the Indian Lycænid, *Polyommatus ariana*. Here the author has inadvertently mixed up at least two species under a single name, his description being taken from one, and his figure from another, while his type specimen does not entirely correspond with either. If only the one, or only the other, had existed, much confusion would have been saved. There are many cases in which a description alone would be amply sufficient, as, for instance, when a new species is described by reference to one well known, and the points of difference enumerated. There are also many cases, in orders other than the Lepidoptera, in which figures, unless highly magnified, would be perfectly useless. Moreover, if this demand were once admitted (even without the impracticable addition of making it retrospective), the amount of illustration required would continually increase, details of structure would be gradually considered essential, and it would at last require many pages and a whole series of plates to describe a new species no whit more effectively than can now often be done in a dozen lines or less with no illustration at all.

With regard to names being "available," when they are universally admitted to be "names," there is less to be said, for I have no wish to waste the time of the Congress by touching on points not under dispute. I have already suggested an

important extension of the present generally-accepted view on pre-occupation, and I should like just to touch on the somewhat obvious fact that no name should be considered available which offends against seemliness or common sense. This wording appears to me preferable to that of the Merton code, as it includes in one term all names that might be offensive (to quote that admirable document) "politically, morally, or by their irreverence," and from other possible causes as well. The other case in which I hold that no name ought to be considered available, is one which will certainly bring me under the lash of those who favour "Priority at any cost," but it tells so directly in securing fixity of nomenclature that I am not without a hope that this Congress may as a whole look favourably on the proposal. The fact that it does so tend to fixity is indeed so obvious that I shall do little more than propound the suggestion, dividing it for the sake of clearness into two parts. I suggest, then :

(1) That no specific or sub-specific name discovered in an earlier publication be held available, if it displace one which has been in universal and unchallenged use for twenty-five years at the time of such discovery ; and

(2) That a generic name with the same prescription shall not be held available in a different, but only in its recognised sense, or in a restricted or extended use of the same.

As an instance, *Papilio* shall not be available for *antiopa*, notwithstanding the discovery of Schrank's action, since it had at the time of this discovery a very long prescriptive application to a group with which *antiopa* is not congeneric.

If twenty-five years be considered too short a period, it might perhaps be extended, though it is a little difficult to see what would be gained either in principle or practice by such an extension even to fifty years. If fixity of nomenclature is ever to be arrived at, even approximately, some such regulation will sooner or later have to be made. The argument with regard to the sacrifice of truth has already been dealt with, and I am not aware that any other has ever been brought forward. Even the stoutest supporters of "Priority without exception" will hardly contend that the *non possumus* attitude can be regarded as coming under that head.

It is possible, however, that I may be told that in admitting any exception whatever I am opening the door to every kind of personal idiosyncrasy. On the contrary, this is the door which of all others I most desire to close. For such an International Committee as is proposed by the Entomological Society of London would be a Court of Appeal by which, in the long run, personal idiosyncrasies would be overruled. I should indeed welcome, if practicable, an arrangement by which a new name should be held to have been only proposed, not published, until it had been registered by such a Committee, it being open to any one to enter an objection before a National Committee to any name proposed, and registration taking place in the ordinary course, if within a given time no objection had been lodged. This course would, if it could be arranged, render all synonymy (beyond the mass which already exists) impossible for the future.

If it be objected that an International Committee already exists, I would reply—not such a committee as our Society proposes, a scheme of which the national committees form a most important part. For not only must the greater part of the work be done by these, but there are points of which they only could take cognizance. For example, the astounding series of generic names, so-called, proposed in the Hemiptera, would in their Greek-looking dress probably pass muster except before an English-speaking committee—I refer to *Ochisme*, *Polychisme*, and the rest—and would not be detected as the frantic appeals of the author for the embraces of his lady friends, tokens of affection from which, in view of the order for which the names were designed, one would have thought he would have preferred to be excused. These names may not be offensive “from their irreverence,” nor “politically,” nor perhaps even “morally,” but they certainly do offend both against seemliness and common sense. They are, of course, self-condemned, and utterly impossible of acceptance.

There are two further points on which I should wish to touch, both referring to varietal and aberrational names. First, though the position is, I know, an unpopular one, I would plead for very serious consideration before any attempt whatever is made to limit the cases to which they may legitimately be applied. To argue that the constant subdivision of species is

practically to revert to pre-Linnean methods (though I confess I cannot see how or why this is the case) is really begging the question. There is no imaginable reason against reverting to a pre-Linnean, or an antediluvian, or even a pre-Adamite plan, if it can be shown to be a good or useful one. The possible abuses of the system are obvious on the surface, but of the two most glaring objections, one, which may be called the mercenary one, has already been met by the rejection of sale-catalogue names, and the other, the synonymic, can be as effectually met by the National and International Committees now suggested. If collectors regard the multiplication of such names as a nuisance, the simple reply is that they are not intended to be used by them. It is to the student of variation and to the biologist alone that they are of value; very small differences will sometimes show the "directions of variation" in a species, and those variations occasionally point out quite unexpected affinities; all these are registered by aberrational names. It would require another (and perhaps even more tedious) paper to work this matter out in detail, and I do not propose now to do more than enter a plea for the fullest recognition of the purpose and utility of such names.

The second point I would urge is one much more likely to meet with popular approval. It is that, as far as possible, parallel variation in related species should be known by the same varietal or aberrational name. The objection that a man cannot describe what he has not seen appears to me absolutely childish. Many parallel variations are known to occur, and if they have as yet only been observed in certain species, why should not a name already given to some form of variation in those species be automatically applied to the same form in related species, if found in them at a date later than that of the name? COURVOISIER's names for the many parallel aberrations of the *Lycaenids* are a case in point, but my meaning will perhaps be better illustrated by another instance. In the *Bulletin de la Société lépidoptérologique de Genève* (vol. i., p. 262), REIFOUS described and figured an aberration of *Melitæa athalia* in which the ground colour was white instead of fulvous. This he aptly named *ab. alba*, and stated that he used the name to apply not to this species only, but to similar variation in other species as well.

He instances in particular *Melitæa dictynna*, *Melitæa didyma*, *Brenthis selene* and *Issoria lathonia*, and the name would therefore generally be held to refer to this form of aberration in those species only. But it would be an immense gain if all such descriptive aberrational names (even if the rule were not made to apply more widely) were held to embrace all parallel variation in all related species.

I have, I fear, touched on too many points, most, if not all, of which have been previously urged by myself or others, and perhaps have tried the patience of the meeting, to whose consideration I must now leave these humble suggestions, not without a hope that some of them at any rate may be found worthy of acceptance.

OBSERVATIONS ON THE CENTRAL AMERICAN ACACIA
ANTS.

By WILLIAM MORTON WHEELER, PH.D., BOSTON, MASS.

THE critics who have recently assailed and even demolished many of the brilliant theories bequeathed to us by the eminent biologists of the latter part of the nineteenth century, have not overlooked the theory of myrmecophilous plants. As originally promulgated by BELT and DELPINO in 1874 and elaborated by BECCARI, HUTH, FRITZ MÜLLER, SCHIMPER, and others, this theory holds that a number of plants, mainly tropical, are protected from their enemies by a body-guard of aggressive ants, and that the plants have been able to enlist the services of these insects by furnishing them with suitable dwellings in the cavities of the stems, leaf-petioles, or thorns, and an unfailing supply of sweet liquid food secreted by the extrafloral nectaries, or of solid food in the form of special bodies containing nutritious oils and proteids. The classical cases which were conceived to place this theory on a firm foundation are the East Indian rubiaceous epiphytes of the genera *Hydnophytum* and *Myrmecodia*, the peculiar neotropical trees of the genus *Cecropia*, and a group of large-thorned acacias peculiar to Central America and Mexico. Other famous cases often cited in this connection are the hollow-stemmed neotropical trees of the genus *Triplaris* and the shrubs of the genus *Cordia*.

TREUB (1888) and RETTIG (1904) have proved that the peculiar cavities in the pseudobulbs of the epiphytic Rubiaceæ have a physiological origin and function quite independent of the ants, which later come to inhabit them, and VON IHERING (1907) and FIEBRIG (1909) have shown that the *Cecropias* have no more need of the Aztecas, which regularly occupy their hollow limbs and feed on their Müllerian bodies, than dogs have of their

fleas. As the ant acacias seem at first sight to furnish even more irrefutable arguments in favour of myrmecophily, I was glad to have an opportunity during the winter of 1910-11 of studying these plants in several localities in Panama and Guatemala. And although my observations are not as complete as I could wish, I believe they are not without interest, and I feel sure that my sins of omission will be forgiven by any future investigator who spends an equal number of hours in the fierce tropical sun and submits to the fiery stings of an equal number of ants.

It will be remembered that BELT (1874) studied the ant acacias in Nicaragua. He found that the delicate, pinnate leaves of these plants bear crateriform nectaries on their petioles and, when young, also minute, bright yellow food-bodies at the tips of their leaflets. He described and figured the huge stipular thorns, which are paired and connate at the base. They are at first filled with a sweet pulp, which is entirely eaten out of both thorns by the ants, through a single opening made near the tip of one of the thorns, and the smooth-walled cavity thus produced is then used as a formicary. The ants explore the surfaces of the leaves, collect the nectar and food-bodies, and in return for these favours are supposed to protect the plant with their stings from the attacks of herbivorous mammals, and especially from the large leaf-cutting ants of the genus *Atta*. The acacia ants which BELT observed were identified by FREDERICK SMITH as specimens of *Pseudomyrma bicolor* Guérin, which is synonymous with *Ps. gracilis* Fabricius. BELT evidently believed that the ants are in some way responsible for the peculiar enlargement of the thorns.

We now know that the relation between the ants and the acacias had been observed long before BELT's time. HERNANDEZ (1651) and JACQUIN (1763) both noticed it in Mexico, and COMMELIN figured the food-bodies, or Beltian bodies, as they are now called, as early as 1697, and PLUKENET as early as 1720. Since BELT's time the acacias have been studied in their native environment only by the Costa Rican naturalist ANASTASIO ALFARO. His observations, however, as reported by EMERY (1891, 1892, 1894), are confined to notes on the various species of ants. All other accounts, such as those of COMMELIN (1697), BECCARI (1884-86), SCHIMPER (1888), and RETTIG (1904), were based

exclusively on herbarium material or on specimens grown in European botanical gardens.

THE SPECIES OF ACACIA AND THEIR DISTRIBUTION.

There seems to be some confusion in regard to the taxonomy of the ant acacias. Recent botanists, following BENTHAM (1842) distinguish three species, and I believe that they are right in so doing, but I believe that the name of one of them will have to be changed. BENTHAM cites the species as *Acacia spadigera* Schlechtendal and Chamisso, *A. sphærocephala* Schlechtendal and Chamisso, and *A. hindsii* Benthham. I have seen all three of these species growing, but unfortunately my knowledge of *A. sphærocephala* is unsatisfactory, because this species was not in flower during my visit to Central America, and as I was unaware of the peculiarity of its nectaries till after I had consulted the literature and the specimens in the Gray Herbarium, I probably overlooked it repeatedly in the field on account of its close resemblance to *A. spadigera*. I did, however, see an isolated bush of *sphærocephala* at Las Sabanas, near Panama City, as I have since learned from examining some leaves and thorns preserved in alcohol with the ants. The species known as *spadigera* and *hindsii* I observed in great numbers, often growing side by side, especially at Escuintla and Patulul in Guatemala. Both species bore fruit, and in a few localities *spadigera* had begun to blossom. The most striking characters of the three species are the following:

A. spadigera Schlechtendal and Chamisso is a shrub growing to a height of 10 to 20 feet, often with rather few and diffuse branches. The stipular thorns are large, swollen, gradually tapering towards their tips, and cylindrical or but very slightly compressed at the base. The leaves have a large crateriform nectary at the base of the petiole, and a series of similar but smaller nectaries, each opposite the insertions of a pair of pinne. The flower-spike is elongate, clavate-cylindrical, with a thick pulpy peduncle bearing the small, dense flowers. The fruit is thick, spindle-shaped, bright red and leathery when mature, with a long, slender beak, and contains a butter-like, sweetish, edible pulp, in which the black seeds are embedded.

A. hindsii Benthham grows to a larger size than the preceding.

At Zacapa, Guatemala, in the valley of the Motagua River, I saw trees 30 to 40 feet in height. The stipular thorns are large, very broad, usually very much flattened at their connate bases, and suddenly tapering towards their points. The extrafloral nectaries are arranged as in the preceding species. The flower-spikes are also cylindrical, but much more slender. The fruit, too, is more slender and curved, with a shorter beak. When mature it is brown and dry and does not contain an edible pulp.

A. sphærocephala Schlechtendal and Chamisso is a shrub of about the same size as *A. spadიცigera*. The stipular thorns are also much as in this species, but usually smaller and of a paler colour. The leaves are furnished with only a single nectary, which is at the base of the petiole. The flower-spikes are globular, the fruit a dry, straight, brown pod, much more slender than in *spadიცigera*, and with a short beak or point.

BENTHAM adopted the specific name *spadიცigera* and *sphærocephala* because he believed that both of these were included under the *Mimosa cornigera* of LINNÉ (1770, p. 677) and WILLDENOW (1806). On turning to the *Systema Naturæ*, however, we find that *M. cornigera* L. was based on JACQUIN'S *M. cornigera*, and this author's description clearly rules out *A. sphærocephala*, since the flowers are described as "in spicam aggregantur densam cylindraceam," and the description of the fruits as "coriacea pulpam continent butyraceam" shows that only the species later described by SCHLECHTENDAL and CHAMISSO (1830) as *spadიცigera* can be meant. I do not hesitate, therefore, to substitute *A. cornigera* for *spadიცigera*, and shall henceforth refer to it only under the former appellation.

It is also possible, I believe, to identify with a reasonable degree of certainty the species of some of the other early descriptions. The earliest of all, that of HERNANDEZ (1651), which he cites under the name *Arbor cornigera* and under the native Mexican name "hoitzmamaxalli," is evidently also *A. cornigera*, since he mentions the "siliquas edules." The species, described by COMMELIN (1697), however, is *A. sphærocephala*, because he says that the flowers are "lutei, numerosi, in globulum, etc.," and that the pods are "fragiles." The species observed by BELT must have been *A. cornigera* and not *sphærocephala*, as SCHIMPER infers (1888, p. 48), because BELT remarks that "at the base of

each pair of leaflets, on the mid-rib, is a crater-formed gland," and the thorns in his figure (1874, p. 218) cannot be those of *A. hindsii*.

The three ant acacias are widely distributed in Central America and Mexico, and *A. spadicigera* is also recorded from Jamaica and the north coast of Cuba.¹ All the species are decidedly tropical and rarely grow above an altitude of 4,000 ft., though they range from Panama to the states of Sinaloa and Tamaulipas in Mexico. In Guatemala and Mexico they are common to both the Atlantic and Pacific littoral, but are absent on the great central plateau. In Nicaragua and Costa Rica the two littoral ranges are, of course, less clearly separated. BELT found *A. cornigera* at Matagalpa in Central Nicaragua, and the same species occurs in Costa Rica as high as Alajuela (about 2,000 ft.), but, according to my observations, does not grow in the immediate vicinity of San José (3,868 ft.), or at Cartago (4,500 ft.).

In this extensive range the three species occupy somewhat different though overlapping stations. *A. hindsii* is known only from Guatemala and Mexico, ranging from near sea-level to somewhat over 4,000 feet. On the west coast of Guatemala, at least, it shows its optimum development at about 600 to 1,200 ft., and specimens are less abundant and more sporadic at higher elevations. It seems to prefer rather dry regions, and

¹ There seems to be some doubt as to the indigenous occurrence of any of the three ant acacias in the West Indies. Prof. N. L. Britton, of the New York Botanical Garden, who has a very intimate acquaintance with the flora of that region, writes me as follows: "As to your *Acacia* question, I have no definite knowledge of the occurrence of any of the three species you mention in the wild state anywhere in the West Indies, but *Acacia spadicigera* has been found in Cuba by various collectors, apparently always after cultivation, though it is just possible it may be wild somewhere in that island. We have specimens from the vicinity of Havana. I have examined the spines of this Cuban material, but I have found no holes in them, and I myself have never seen the plant living in Cuba."

Brother Leon, of the order of Christian Brothers, whom I recently met in Havana, informs me that he has had under observation a number of *Acacia cornigera* trees in Cuba, and that he has never found ants in their thorns. A number of these, which he kindly forwarded to me, are very large, unperforated, and normal in all respects.

occurs even at Zacapa, a locality noted for its extreme aridity. The two other species require more warmth and moisture, and have therefore a more limited hypsimetrical range. Of *A. sphaerocephala* I am unable to speak from much personal observation, but *A. cornigera* will, I believe, be rarely found above an altitude of 1,200 ft. I have already mentioned the fact that it and *A. hindsii* often flourish side by side. This is the case at Escuintla and along the piece of the Panamerican Railway connecting Santa Maria and Patulul. As BELT observed, the acacias do not grow in the forests, but only in the open country or savannahs and along road-sides. They spring up readily in clearings, as one may observe at Quirigua, in the banana plantations of the United Fruit Company. The general distribution of these plants in Central America and Mexico can be inferred from the following list of localities compiled from the literature, and from specimens in the Gray Herbarium and in my own collection :

Acacia cornigera L. (= *spadicigera* Schlechtendal and Chamisso). "Cuernezuela," "Torero," "Palin," "Hoitzmamaxalli."

Colombia : Carthagena (JACQUIN).

Panama : (CUMING) Benth.

Costa Rica : Alajuela (J. D. SMITH), Gray Herb. ; Nicoya (H. PITTIER), Gray Herb.

Nicaragua : Matagalpa (THOS. BELT).

Guatemala : Escuintla, 1,100 ft. (J. D. SMITH), Gray Herb. ; Escuintla and Santa Maria to Patulul, 413 to 1,111 ft. ; Los Amates, Iguana, and Quirigua (W. M. WHEELER).

Mexico : Cozumel I., Yucatan (Kew Gardens), Gray Herb. ; Merida and Xcholac, Yucatan (C. F. MILLSPAUGH) ; Vera Cruz (HOUSTOUN), Benth. ; Laguna Verde, Vera Cruz (SCHIEDE), Schlechtendal and Chamisso ; San Francisco, near Vera Cruz (C. L. SMITH), Gray Herb. ; Los Cocos, Vera Cruz (A. PETRUNKEWITCH), Amer. Mus. Coll. ; Jalapa (RANGEL), Amer. Mus. Coll. ; Las Palmas, San Luis Potosi (C. G. PRINGLE), Gray Herb. ; Huasteca (L. V. ERVENDBERG), Gray Herb.

Acacia hindsii BENTHAM.

Guatemala : Zacapa and Quirigua, Escuintla and Santa Maria to Patulul, Llano, Palin, Amatitlan, Eureka, 4,686 ft. ;

near San Lucas Toliman, Lake Atitlan 4,000 ft. (W. M. WHEELER); Rio de las Cañas, Punta Rosa, 2,000 ft. (HEYDE and LUX.), Gray Herb.

Mexico: Manzanilla Bay (HINDS), Benthams; Manzanilla, Colima (C. H. T. TOWNSEND), Amer. Mus. Coll.; La Orilla and San Luis between Michoacan and Guerrero (MICHELE), Gray Herb.; Jamiltepec to Rio Verde 400 to 1,000 ft. (E. W. NELSON), Gray Herb.; between Llano Grande and Pinotepa, 200 to 500 ft. (E. W. NELSON), Gray Herb.; Escuinapa, Sinaloa (J. H. BATTY), Amer. Mus. Coll.

Acacia sphærocephala SCHLECHTENDAL AND CHAMISO.

Panama: Las Sabanas (W. M. WHEELER).

Mexico: Actopan, Vera Cruz (SCHIEDE), Schlechtendal and Chamisso; Vera Cruz to Texas (BENTHAM); Yucatan (G. F. GAUMER), Gray Herb.

OBLIGATORY AND FACULTATIVE ACACIA ANTS.

Just as there are certain species of the dendrophilous ant-genus *Azteca* that live only in *Cecropia* trees, so there are certain species of the equally dendrophilous genus *Pseudomyrma* that live exclusively on the three large-thorned acacias. These I shall call "obligatory" acacia ants. Several other species of the same genus, which are only occasionally associated with these plants, may therefore be designated as "facultative." To the former group belong the three species which EMERY determined, from specimens collected by ALFARO in Western Costa Rica, as *Ps. belti* Emery, *spinicola* Emery, and *nigrocincta* Emery. These species are all of about the same size, but differ in colour, *belti* being black, *spinicola* red, and *nigrocincta* yellow, with a black band across the base of the gaster. I may note in passing that Dr. P. P. CALVERT recently sent me specimens of *Ps. belti* and *nigrocincta*, taken from acacia thorns in Santa Cruz, Guanacaste, Costa Rica. I have taken *spinicola* only in Panama on *A. sphærocephala*. In Guatemala the only obligatory *Pseudomyrma* seen on *A. conigera* and *hindsii* are the typical *belti*, and a red subspecies of this ant, *fulvescens* Emery, the former occurring very rarely, the latter on nearly all the trees. In a foot-

note to his paper (1892) EMERY states that the types of *fulvescens* were found by BECCARI in the hollow twigs of *Cordia gerascanthos* in Guatemala, but I believe that this must be a very exceptional occurrence, as *fulvescens* is certainly the most abundant and most typical acacia ant on both the east and west coasts of Guatemala and was taken by me on no other plants. It occurs in two varieties, a larger and a smaller, the former running about with its gaster directed backward in line with the thorax, the latter with the gaster bent forward under the thorax after the manner of *Ps. künckeli* Emery.

BELT mentions only *Ps. gracilis* (= *bicolor*) as occurring in the thorns at Matagalpa, Nicaragua, and as this ant is very common in the hollow twigs of the most various trees and shrubs throughout tropical America, EMERY was inclined to believe that BELT's specimens must have been incorrectly identified by FRED. SMITH. But such a supposition proves to be baseless, since at Quirigua I found a region in the banana plantations where *Ps. gracilis* is the only ant occurring in the acacia thorns. It thus appears that the obligatory ant fauna of the acacias differs in different parts of Central America, although it comprises, so far as known, only four forms: *Ps. belti* and its subspecies *fulvescens*, *Ps. spinicola* and *nigrocincta*. These differences are produced merely by a great local predominance of one or two of the species over the others.

The facultative Pseudomyrmas comprise, so far as known: *Ps. gracilis*, mentioned above; *Ps. subtilissima*, a single colony of which was taken by ALFARO in a tree occupied by *Ps. belti*; and *Ps. nigropilosa* Emery, of which DR. CALVERT sent me a few specimens taken in acacia thorns at Santa Cruz, Costa Rica. We must also assign three other ants of different genera to this group of facultative species; namely the *Crematogaster* mentioned by BELT as living in the thorns of some of the trees in Nicaragua, *Camponotus planatus* Roger, also nesting in the thorns, and a minute yellow *Solenopsis* sp., which I found nesting in the flower peduncles. To the *Solenopsis* and *Camponotus* I shall return after discussing the relations of the obligatory Pseudomyrmas to the acacias.

In Guatemala I found no ants on the dead acacias, which are always abandoned by the obligatory Pseudomyrmas, but ALFARO

was more fortunate in Costa Rica. He sent EMERY the following species taken from the thorns of such trees: *Ps. gracilis* var. *mexicana* Roger, *Ps. nigropilosa* Emery, *Ps. künckeli* Emery, *Crematogaster brevispinosa* Mayr, *Cryptocerus minutus* F., *Cryptocerus* sp. (near *discocephalus* F. Sm.), *Camponotus rectangularis* Emery and *Colobopsis* sp. All or nearly all of these occur in the hollow branches of a great variety of trees and shrubs.

By way of summary I subjoin a list, with localities, compiled from the literature and my collection, of the ten species which are known to occur in the living acacias.

Pseudomyrma belti EMERY.

Costa Rica: Alajuela, Jimenez, Liberia (A. ALFARO); Santa Cruz, Guanacaste (P. P. CALVERT).

Nicaragua: (WM. FLUCK); Grenada (C. F. BAKER); Chontales (FOREL in *Biol. Cent. Amer.*).

Guatemala: Escuintla (W. M. WHEELER).

Mexico: Manzanilla, Colima (C. H. T. TOWNSEND); Escuinapa, Sinaloa (J. H. BATTY); Acapulco (C. F. BAKER); Orizaba (H. DE SAUSSURE).

Ps. belti fulvescens EMERY.

Colombia: Sabanilla (C. GAGZO).

Nicaragua: Grenada (C. F. BAKER).

Guatemala: Zacapa, Quirigua, Escuintla, Patulul (W. M. WHEELER); Champerico (FRED. KNAB).

Mexico: Santa Lucrecia, Vera Cruz (FRED. KNAB); Cordoba (FRED. KNAB); Los Cocos, Vera Cruz (A. PETRUNKEWITCH); Jalapa (RANGEL); Tampico (H. JOURDAN); Torola, Chiapas (A. PETRUNKEWITCH).

Ps. spinicola EMERY.

Panama: Las Sabanas (W. M. WHEELER).

Costa Rica: Alajuela, Jimenez, Pozo Azul (A. ALFARO); Subures near San Mateo.

Nicaragua: Chontales (JANSON).

British Honduras: Belize and Manatee (J. D. JOHNSON).

Mexico: Teapa, Tabasco (H. H. SMITH); Acapulco (FRED KNAB).

Ps. nigrocincta EMERY.

Costa Rica : Alajuela and Jimenez (A. ALFARO) ; Santa Cruz, Guanacaste (P. P. CALVERT).

Ps. nigropilosa EMERY.

Costa Rica : Santa Cruz, Guanacaste (P. P. CALVERT).

Ps. gracilis FABR.

Guatemala : Quirigua (W. M. WHEELER).

Ps. subtilestissima EMERY.

Costa Rica : Alajuela (A. ALFARO).

Crematogaster SP.

Nicaragua : Matagalpa (BELT).

Solenopsis SP.

Guatemala : Escuintla (W. M. WHEELER).

Campanotus planatus ROGER.

Guatemala : Costa Rica (A. ALFARO) ; Zacapa, Quirigua, Escuintla, and Patulul (W. M. WHEELER).

THE HABITS OF THE OBLIGATORY PSEUDOMYRMAS.

As BELT observed, the stipular thorns of the acacias are at first rather soft and green, and contain a watery, sweetish pulp. Only after they reach their full size and shape do the ants pay any attention to them. Then the insects select a spot near the tip of one of the thorns of each pair, make an elliptical hole in the cortex, and dig out the pulp. I am not sure that the ants eat this pulp, as BELT implies, but this is not improbable, considering its sweet taste and the large amount of water it contains. After one thorn is hollowed out, the excavation is carried through its base into the adjoining one, which is also reduced to a mere shell. All the particles excavated from both thorns are carried out through the single orifice, and one almost never sees a pair of thorns with an opening near the tip of each. During or just

after the process of excavation the cortex and tips of the thorns harden and turn brown, and the ants take up their dwelling in the hollow structure. A single branch may display in sequence the various stages in this excavation and habitation, the old thorns at the base being filled with ants and their brood, the more distal thorns completely hollowed out, and only just tenanted, and the green thorns at the tip of the branch still intact or with merely the beginnings of an aperture or a small excavation in the pulp itself.

It occasionally happens that the ants overlook thorns which have reached the right stage for excavation. These nevertheless mature and turn brown exactly like the inhabited thorns, and when cut open are seen to have become hollow through a drying up of the pulp. It is evident, therefore, that unless the ants utilise the pulp as food, they are really wasting their time and energy in excavating the green thorns, since they would achieve the same results much more easily by boring through the cortex of old thorns. They would then merely have to remove the few fibrous remnants of the pulp, and the thorns would be ready for habitation. Such behaviour would, of course, require a greater initial effort in perforating the harder cortex of the old thorns.

The structure of the Beltian bodies has been carefully studied by MENEGHINI and SAVI (1884), FRANCIS DARWIN (1877), and SCHIMPER (1888), who all agree in regarding these peculiar structures as the homologues of the serration-glands on the leaf-borders of many other plants. At first I had some difficulty in finding the Beltian bodies, because I looked for them on large trees, from which they had been removed by populous colonies of ants; but later I detected them readily. Only on one occasion, however, was I fortunate enough to see the ants in the act of collecting them. This was while I was walking in the outskirts of Patulul, along a road which was bordered with a hedge of *Erythrina* trees. Among these stood two *A. cornigera* bushes, about 8 ft. apart, with their trunks connected by barbed wires, along which were passing processions of *Ps. fulvescens* workers, each bearing a minute yellow body in its mandibles. Closer inspection showed that one of the trees was peopled by a large colony of *Pseudomyrmas*, and that they had just discovered, on the young leaves of the other uninhabited tree, an abundant

supply of Beltian bodies, which they were now busily plucking and carrying home, over the barbed-wire bridges, to their nests in the thorns. Later I found that the Beltian bodies are, as a rule, so eagerly sought and so quickly removed from the young leaves of trees inhabited by vigorous colonies, that none of these structures is to be found on the leaflets by the time they unfold.

The liquid food-supply is derived by the ants from the extra-floral nectaries on the upper surface of the leaf-petioles, and in all probability also from the pulp in the young thorns. As in other plants, the nectar is produced most abundantly on the young leaves and in the early morning, so that the ants are most assiduous in collecting the supply at this time, though some of them may be seen exploring and licking the dry surfaces of the nectaries and visiting other parts of the leaves, both old and young, at all hours of the day.

Shaking or roughly touching the branches at once excites the ants. The shock itself, or possibly some stridulatory signal emitted by the insects that first feel the shock, is transmitted to the ants in the thorns. Without a moment's hesitation the angry creatures issue from the small elliptical apertures, rain down upon the intruder, and thrust their burning stings into his flesh. While stinging the *Pseudomyrma* curves its body in an arc and bites with its mandibles at the same time, often persisting in this position till it is torn away from the skin. The pain thus produced is considerable and may endure for hours, though it is confined to a very limited area. The sting of *Ps. spinicola* is somewhat more painful than that of *Ps. belti* or its subspecies *fulvescens*.

The foregoing observations agree very closely with BELT's, and certainly at first sight suggest an intimate symbiotic relationship between the ants and the acacias. There is, of course, nothing remarkable in the ants' utilising the nectar and food-bodies, because almost any dendrophilous ants would do this, but the uniform and purposeful method of excavating and inhabiting the thorns certainly implies a singular degree of familiarity with the suitability and consistency of these structures. But the matter assumes a different aspect when we consider *Ps. gracilis*. This ant, which is highly variable in colour and one of the largest and most abundant species of the genus throughout

tropical America from Brazil to Southern Texas, nearly always nests in hollow twigs and shows merely local preferences for certain kinds of trees and bushes ; but in Nicaragua, where BELT made his observations, and in one locality in Quirigua, Guatemala, as previously stated, this ant has taken to nesting in the acacia thorns. It hollows these out in precisely the same manner as do the regular *Pseudomyrmæ*, making the aperture at the same point near the tip of one thorn of each pair. The aperture, however, is larger because it has to admit larger ants, and for the same reason it takes very few *gracilis* workers, larvæ, and pupæ, to fill the cavity of a pair of thorns. Such rapid and perfect adaptation on the part of *Ps. gracilis* indicates that no special hereditary instinct modification may have been required to induce the same adaptation in *Ps. belti*, *spinicola*, and *nigrocincta*, for these three species, like *gracilis* and many other *Pseudomyrmas*, very probably once nested in all kinds of trees.

BELT's observations, however, suffer from an erroneous supposition and an important lacuna. After correctly describing the way in which the ants hollow out the thorns, he says (1874, p. 221) : " Strange to say, this treatment seems to favour the development of the thorn ; whilst in my plants that were not touched by the ants, the thorns turned yellow and dried up into dead but persistent prickles. I am not sure, however, that this may not have been due to the habitat of the plant not suiting it." This cautious statement in regard to the enlargement of the thorns becomes a very positive one in BECCARI's account of the ant acacias (1884-86), where he says : " Mi sembra indubitato che tale maggiore rigonfiamento debba attribuirse alla irritazione prodotta dalle formiche." He reached this conclusion, which has also been repeated by more recent writers, from finding that the thorns of *A. cornigera* grown in Italy, and therefore free from ants, were less curved and dilated at the base than the thorns of some herbarium specimens that had been inhabited by ants. It never occurs to him that the thorns may be highly variable, even on the same tree, as indeed they are ; just as it seems never to have been observed by BELT that a certain number of thorns often remain small and turn yellow even on large, healthy trees. This, together with the fact recorded above, that the thorns are entered by the ants only after they have attained

their full size and characteristic shape, or at any rate at once cease growing and turn brown as soon as they have been hollowed out, suggests an interesting question as to the true cause of the enlargement of the thorns.

The important lacuna in BELT's account is the lack of any observations on the first invasion of the young acacia by the ants. That he endeavoured to answer this question, but failed, is clear from the following quotation: "I sowed the seeds of the acacia in my garden, and reared some young plants. Ants of many kinds were numerous; but none of them took to the thorns for shelter, nor the glands and fruit-like bodies for food; for as I have already mentioned, the species that attend on the thorns are not found in the forest. The leaf-cutting ants attacked the young plants and defoliated them, but I have never seen any of the trees out on the savannahs that are guarded by the *Pseudomyrma* touched by them, and have no doubt the acacia is protected from them by its little warriors."

It is regrettable that BELT failed to observe seedling acacias in their native savannahs, for had he done so he might have modified his views in regard to the myrmecophily of these plants. But seedling acacias are rare even where the bushes and trees abound. Quirigua was the only locality in which I succeeded in finding them, probably because the dry season was prevailing in all the other places I visited in Guatemala. In the clearings that were being made for the banana plantations, I found many young plants of *A. cornigera* between 8 in. and 2 ft. in height. Several of these, though vigorous and almost in the very paths of large colonies of leaf-cutters, were nevertheless perfectly free from *Pseudomyrmas*. The thorns of others, however, contained isolated, recently fecundated queens of *Ps. fulvescens* or *Ps. gracilis* in the act of establishing their colonies. Brief descriptions, drawn from my note-book, of two of these plants will suffice. One, only 8 in. high, bore but a single pair of thorns, which were hollow and contained a solitary deälated queen of *Ps. fulvescens*. She had made the typical opening near the tip of one of the thorns, and was evidently waiting for the eggs to mature in her ovaries. Another plant, 14 in. high, was more interesting. It bore 5 pairs of thorns, each of the three basal pairs of which was inhabited by a deälated queen; the two

distal pairs were green and still intact. The queen in the lowermost pair was guarding a few larvæ and pupæ; the two others had as yet produced no young, and, curiously enough, the orifices through which they had excavated and entered the thorns had grown over and closed, though their position was still marked by a scar on the outside. This closure, which I observed also in some of the other seedlings, recalls the conditions in *Cecropia*, each young internode of which is perforated by the *Azteca* queen at a preformed pit, which then closes over by the growth of the plant, so that the insect is imprisoned till the wall is again perforated at the same spot, but from the inside, by the worker brood, and the young colony establishes its communication with the outside world.

It is evident, therefore, that it is the queen *Pseudomyrma* that attaches the ant colony to the acacia, by a type of behaviour which is merely repeated by her offspring when they hatch and enlarge the colony by excavating and moving into additional thorns as fast as these mature on the more terminal portions of the trunk and branches. My observations also show that even when the seedling acacias grow in localities where the leaf-cutting *Attas* abound, they cannot be protected by the *Pseudomyrmæ* till they are more than a foot high, for the queens do not leave their thorns, since they are at this period as timorous as all young isolated ant queens. Moreover, the closure of the openings of the thorns would prevent many of them from defending the plants, even if they were so inclined.

A more difficult question is that relating to what must occur when the young broods, produced by the various queens that occupy successive thorns, come forth on to the surface of the plant in search of food. Do these broods fight with one another till only one and its queen survive, as VON IHERING believes to be the case among the *Cecropia* Aztecas? Or do the various broods fraternise and fuse to form a single, large, polycladic colony? I am unfortunately unable to decide between these alternatives, but I am inclined to believe that the various broods unite, and that the thousands of ants which occupy all the thorns on a single tree represent a colony which arose by a coalition of the broods of all the queens that peopled the few available thorns on the very young plant *plus* the broods that have been produced

by the daughters of these queens moving into thorns on the same tree as fast as these became suitable as dwellings. That different colonies of the same species of *Pseudomyrma* may thus readily coalesce is also indicated by the fact that these ants so readily tolerate the presence of certain other distantly related species on the same tree, as I shall now proceed to show.

THE CASES OF PARABIOSIS.

It is usually supposed that only one species of ant occurs on an acacia tree, but we have seen that ALFARO on one occasion found both *Ps. belti* and *subtillissima* living side by side, and this observer also found a second ant, *Camponotus planatus*, on trees inhabited by the *Pseudomyrmas*. EMERY'S account of these observations is not altogether clear. He seems to imply that the *Camponotus* is merely a "Raumparasit," or inquiline of the *Pseudomyrma*, and that it prefers to occupy the thorns of the dry or dead branches. *C. planatus* is, according to my own observations, one of the most abundant neotropical ants, and has much the same distribution as *Ps. gracilis*. Like this ant it usually nests in the hollow twigs of a great variety of trees and bushes. It is timid and very rapid in its movements, and in its foraging and feeding habits resembles the other small arboreal species of the huge genus *Camponotus*. I was surprised, therefore, to find this ant on a large proportion of the living *A. cornigera* and *hindsii* bushes at Escuintla, Patulul, and Quirigua, in company with *Ps. fulvescens*, which it resembles in colour though not in form. I was still more surprised to find it associated in the same manner with the large black *Ps. gracilis* at Quirigua, where this ant has become a common acacia tenant. In all of these localities and, as I have said, in many of the trees, a large number of the thorns were occupied by *C. planatus*. And these thorns were on the same twigs and branches as those occupied by *Ps. fulvescens*. The thorns containing the *Camponotus* are easily recognisable, for they have larger openings because the body of this ant, though shorter, is stouter than that of the *Pseudomyrma*.

That the *Camponotus* does not, as EMERY supposed, merely take possession of thorns excavated and abandoned by the *Pseudomyrma*, was proved on one occasion when I found a small

group of *Camponotus* workers busily engaged in perforating a green thorn. It is probable, therefore, that the *Camponotus* queens, after their nuptial flight, seek out the acacias and enter their young thorns even when the trees are already inhabited by the *Pseudomyrma*, and that the *Camponotus* workers continue this work side by side with the *Pseudomyrmæ*, both species competing for and taking possession of the thorns as fast as they attain the proper size and maturity. It is certainly extraordinary that *C. planatus*, which throughout tropical America so constantly lives in hollow twigs, should be able in widely separated localities to utilise the acacia thorns as perfectly and in precisely the same manner as the regular *Pseudomyrmas*. That the *Camponotus* is, if anything, even more adroit in its use of the extrafloral nectaries becomes apparent when one follows the ant as it moves over the leaves, for it begins with the nectary at the base of the petiole and carefully visits each in turn, whereas the foraging *Pseudomyrmas* are much more desultory and less businesslike. I have not seen the *Camponotus* collecting the Beltian bodies, but I doubt not that they make quite as good use of them as of the nectar.

The behaviour of the two species of ants towards each other is peculiar. They seem never to quarrel, and, if not too close together, pass one another on the twigs and leaves with an air of complete indifference. But when two of them happen to meet squarely face to face, each starts back suddenly and, curiously enough, the *Pseudomyrma* always recoils more vigorously than the *Camponotus*. There is something ludicrous in this behaviour, because both ants are of about the same bulk, and the *Pseudomyrma* is really the more powerful and possesses a formidable sting, whereas the *Camponotus* is much less pugnacious and can defend itself only with its rather feeble mandibles and formic acid battery. But it smells rather strongly of formic acid, and I believe that this produces the more decided reaction on the part of the *Pseudomyrma*.

Still another ant which I found repeatedly nesting in *A. cornigera* bushes with *Ps. fulvescens* in a pasture near Escuintla, Guatemala, is a minute yellow *Solenopsis*, which seems not to have been described. Its small colonies were not nesting in the thorns, but in the old spindle-shaped flower-peduncles from which

the ripe fruit had fallen. The ants had converted each peduncle into a nest by providing it with a small circular opening, and removing the pulpy tissue from its interior. In all these nests, and attached to their walls, were several small reddish Coccids, the excrement of which is probably an important part of the ant's food. I did not see the *Solenopsis* out on the stems and foliage, but even if they are in the habit of frequenting the surfaces of the plant, they are probably completely overlooked by the *Pseudomyrmæ* on account of their minute size. Similar small yellow species of *Solenopsis* (*S. fugax* Latr., *S. molesta* Say, etc.) are known to live in the walls of the earthen nests of various European and North American ants and to prey on their larvæ and pupæ. It would be interesting to know whether the acacia *Solenopsis* ever assumes a similar lestopibiotic relation towards *Ps. fulvescens*.

I believe that we may regard the relationship existing between *Ps. fulvescens* and *gracilis* on the one hand, and *Camponotus planatus* on the other, as one of parabiosis. This term was first introduced by FOREL in 1898 to designate a peculiar pacific relationship between *Dolichoderus debilis* and *Crematogaster parabiatica*. He found these two ants in Colombia nesting in an abandoned termite nest, in such a manner that each species kept its brood together in its own chambers and galleries, but the chambers and galleries of the one species interdigitated and even inoculated with those of the other in a very intimate manner. The two species, moreover, foraged together on the same plants, either separately or in a common file. Each of them was also found nesting by itself. I may say in passing that I found no less than a dozen colonies of these same ants in Panama and Guatemala, and in all cases their nests presented essentially the same peculiarities as those described by FOREL. Their foraging habits, too, conformed with his description. MANN (1912) has very recently described similar parabiiotic relations between certain Brazilian ants (*Dolichoderus bispinosus* Oliv. and *Crematogaster* sp.; *Odontomachus affinis mayi* Mann and *Dolichoderus debilis* var. *rufescens* Mann). Some years ago I also included under the head of parabiosis the cases in which different species of neotropical ants show a tendency to inhabit the same Tillandsias and other Bromeliaceous epiphytes. To these various

cases may now be added the association of *Ps. belti* with *Ps. substillissima*, and of *Ps. fulvescens* and *gracilis* with *C. planatus*.

OTHER ORGANISMS ASSOCIATED WITH THE ACACIAS.

It is probable that other insects besides the ants occasionally visit the extrafloral nectaries of the acacias. BELT states that these organs are "frequented by a small wasp (*Polybia occidentalis*)."

But besides the ants and the Coccids mentioned above as living in the hollow flower peduncles of *A. cornigera*, I saw only the following insects or evidences of their occurrence on the plants:—

1. In some localities (Escuintla, Patulul) the upper surfaces of the pinnæ of *C. cornigera* bore beautiful little spherical galls, 5 to 6 mm. in diameter, singly or in clusters, and resembling minute strawberries, as they were bright red and uniformly covered with papillæ. Each of these galls contains a Dipteran (Cecidomyiid?) larva and has a preformed rhaphe along which it dehisces when brown and mature, and permits the adult fly to escape. *Ps. fulvescens* is very fond of visiting these galls when young and succulent, and was often seen gnawing away the covering of papillæ, but not eating in far enough to injure the enclosed larva.

2. A second gall of larger size and woody texture was occasionally seen on the flower stems of *A. hindsii*, but as I saw only old and dried specimens, I am unable to make any statement in regard to the insect.

3. The brilliant yellow flower spikes of *A. cornigera* are pollinated by small bees which resemble some of our northern species of *Halictus*.

4. On some of the acacia trees and bushes I found the paper nests of various species of *Polybia*, some deserted, but others still occupied by the wasps.

5. Along a road near Escuintla I found several young acacias wholly or in part defoliated, though their thorns were still teeming with *Ps. fulvescens*. There were no leaf-cutters in the vicinity, and the defoliation was not of the type characteristic of these ants, but resembled that of certain caterpillars or Chrysomelid beetle larvæ.

Finally I may mention that I occasionally found well-constructed but abandoned birds' nests in the acacias. If these at some former period really contained young birds, it is difficult to see how these could have escaped being molested by the *Pseudomyrmas*.

THE ANT ACACIAS OF SOUTH AMERICA AND AFRICA.

Since BELT described the Central American acacias, species with similar relations to ants have been discovered in South America and Africa, and as these are not without interest in connection with the foregoing observations, I may be pardoned for briefly discussing them.

South American ant acacias are known only from Paraguay. In 1896 EMERY enumerated the following series of ants as having been found by DR. J. POHLS nesting in the robust, wooden thorns of a species of *Acacia* in that country: *Pseudomyrma acanthobia* Emery, *Leptothorax spininodis* Mayr, *Cryptocerus pusillus* Klug, *pilosus* Emery, *bohlsi* Emery, *peltatus* Emery, *quadratus* Mayr, *pallens* Klug, *grandinosus* F. Smith, *Crematogaster brevispinosa* Mayr, and *Myrmelachista nodifera* Mayr var. *flavicornis* Emery. Most of these species seem merely to excavate galleries in the woody tissue of the thorns, without hollowing them out after the manner of the Central American ants. *Ps. acanthobia* perforates the thorns near the tip, the other species nearer the base. The latter often make several openings in the same thorn.

Much more like the conditions in the Central American acacias are those recently described by FIEBRIG (1909) for *Acacia cavenia* H. and A. of Paraguay. The pairs of thorns on this tree are often greatly enlarged and are frequently inhabited by an ant, *Ps. fiebrigi* Forel, which makes its opening near the tip of one of the thorns. FIEBRIG found that the thorns are often hollowed out by a Tineid larva, and he believes that the cavities thus formed are later appropriated by the *Pseudomyrma*. No Beltian bodies were found on the few plants on which they were sought, and no mention is made of the extrafloral nectaries. The acacia grows only in low grounds which are occasionally flooded, and where there are no leaf-cutters.

Even more interesting are the East African ant-acacias which

have been studied by KELLER (1892), and more recently and somewhat more closely by SJÖSTEDT (1908). These acacias are *A. fistula* Schweinf., *zanzibarica* Taub., *drepanolobium* Harms, *seyal* Del., and *bussei* Harms. Their stipular thorns exhibit a much greater variety of shape and a much more extraordinary enlargement at the base than is found in any of the American species. So extreme is this enlargement, in fact, that SJÖSTEDT regards them as galls, and believes that they may owe their development to the stings of Diptera or Hymenoptera or, more probably, to the irritation produced by certain Coccids which he found on the very young twigs. Both KELLER and SJÖSTEDT, however, are certain that the ants have nothing to do with the modification of the thorns, since they found them attaining their full size before being entered by the ants, and also on bushes that harboured none of these insects. The galls are at first solid and are hollowed out by the ants. These belong mostly to the dendrophilous genus *Crematogaster*. The species taken in the thorns of *A. fistula* by KELLER and identified by FOREL (1892) were *C. chiarinii* Emery, *acaciæ* Forel, and *ruspolii* Forel. SJÖSTEDT took *C. chiarinii* in the thorns of *A. zanzibarica*; *C. admota* Mayr, *C. sjöstedti* Mayr, and *Sima penzezi* Mayr in those of *A. drepanolobium* and *C. solenopsidis* Emery var. *flavida* Mayr and *Cataulacus intrudens* F. Sm. in the thorns of *A. bussei*. The various *Crematogasters* do not perforate the tips of the thorns, like the *Pseudomyrmas*, but make one or more round holes in the dilated basal or gall portion. It may be noticed in passing that the *Crematogaster* which BELT found nesting in *A. cornigera* has the same habit. The African acacias bear no Beltian bodies, although they are furnished with crater-shaped nectaries on the leaf-petioles. SJÖSTEDT failed to observe the ants in the act of visiting these nectaries, but he admits that they may do so when the leaves are very young. One infers from his description that the ants obtain their food largely from the numerous Coccids (*Dactylopius coccineus* Newst.) and larval Membracids which infest the plants. Both KELLER and SJÖSTEDT believe that these acacias of the African plains may be protected from the antelopes, goats, and camels by their ants, although these are certainly far less vicious than the American *Pseudomyrmas*. It is, however, by no means clear that the plants are

not sufficiently protected by their long, sharp thorns from the browsing animals.¹

ARE THE ACACIAS MYRMECOPHILOUS?

After presenting all the essential facts, so far as known, concerning the acacias and their ants, we are prepared to consider the question as to whether these plants are actually myrmecophilous, as implied in the Belt-Delpino hypothesis. In other words, have these plants developed their extraordinary thorns, extrafloral nectaries, and Beltian bodies for the purpose of insuring the presence of a body-guard of stinging ants? It is certain that acacias that are quite free from ants grow and flourish quite as well as ant-infested individuals, and produce the thorns, nectaries, and Beltian bodies in a perfectly normal manner. This I have found to be the case in a few localities in Western Guatemala, and also, under interesting circumstances, in the banana plantations about Quirigua. In the latter locality the negroes, while making clearings, had carefully lopped off all the branches of many of the old acacias, leaving only their stumps. These had then put forth vigorous young branches, which, however, were quite free from ants, evidently because they had grown out, and their spines had matured at a time when the recently fecundated *Pseudomyrma* queens were not flying about in search of nesting sites. Finally, attention may be again called to the fact that the very young acacias, which would seem to require the greatest amount of protection, are either entirely free from ants, or contain only young queens hidden away in the hollow thorns.

¹ Since the foregoing paragraphs were written, Dr. Glover Allen, of the Boston Society of Natural History, has, at my request, made some interesting observations on the enlarged thorns of *Acacia fistula* in the Blue Nile and Dinder River Valley, while accompanying Dr. J. C. Phillip's Sudan Expedition. On cutting open very young thorns, which were only slightly swollen at the base, he found them to consist "of a solid mass of green, succulent tissue, with a single small larva inside, as in a typical insect gall." This larva seemed to be that of some Hymenopterous insect. His observations, which will be published in detail later, show very clearly that the enlarged thorns are not only galls, which are formed independently of the ants, as SJÖSTEDT observed, but that these structures are inhabited by very few ants during January and February.

The Belt-Delpino hypothesis clearly implies that unless protected by the *Pseudomyrmas* the acacias would be destroyed either by the browsing cattle or by the leaf-cutting ants. Yet it must be evident at once, to any one who sees these plants growing in the savannahs of Panama and Guatemala, that their thorns alone would protect them from the attacks of horses and cattle, for these thorns are not weak or ineffective, as some writers seem to imagine, but are, as RETTIG says, at least as formidable as the thorns of many species of hawthorn (*Crataegus*). I should say that they are even more formidable than any of the thorns I have seen on the numerous hawthorns growing in the Arnold Arboretum.

Most authors, however, dwell more on the leaf-cutting ants of the genus *Atta* as the principal enemies of the acacias. BELT's seedlings were destroyed by these pests, and I willingly admit that a similar fate may occasionally overtake these plants in Guatemala, although I never saw one attacked, even in Quirigua, where both seedlings and older bushes grow in the clearings near the large *Atta* formicaries, and almost in the beaten paths of the ants. In other localities, such as Zacapa and Patulul, I was often unable to find leaf-cutters in any part of the extensive areas occupied by the acacias. From my observations on these ants in Panama, Costa Rica, Guatemala, Mexico, and Texas I am convinced that their rôle as destroyers of plant-life has been grossly exaggerated, and VON IHERING and FIEBRIG have acquired the same conviction from their observations in Brazil and Paraguay. The *Attas* do, indeed, occasionally defoliate trees or shrubs, but they are not sufficiently numerous to do this over any considerable area, nor so thoroughly and repeatedly as to endanger the existence of any native plant species. That they often destroy introduced or cultivated plants, such as rose bushes, is true, but these are grown in small, compact cultures, and are not scattered over immense stretches of country, much of which is always quite free from *Atta* colonies. I conclude, therefore, that the existence of the acacias as species is very far from being endangered by the leaf-cutters. What, then, are the great destroyers, against which such a body-guard of stinging ants has to be levied, garrisoned, and fed by the acacias? As nobody is able to tell us, are we not justified in casting the *onus*

probandi of myrmecophily on the shoulders of him who affirms its existence?

But when answered in this manner, the advocate of myrmecophily shifts his ground and says that the acacias have obviously survived a multimillennial struggle with enemies which are now either much reduced in numbers and hostility, or have altogether perished, and that it was during this struggle that the plants were compelled to hold out inducements to an emmet body-guard, which is perhaps at the present time nothing more than a useless survival. Such arguments, in the face of our complete ignorance of the past history of the ant acacias, may be passed over without comment, or by merely pointing to the fact that there are in Central America and Mexico many other species of *Acacia* and acacia-like plants, with equally delicate foliage, and growing in the same localities, but without enlarged thorns, extrafloral nectaries, food-bodies, and attendant ants. Why have these more numerous and more defenceless species survived without the assistance of the *Pseudomyrmas*?

I admit that the thorns, extrafloral nectaries, and food-bodies are peculiar structures requiring an explanation. But such an explanation should first be sought along physiological lines. Madame VON ÜXKÜLL-GÜLDENSTERN (1907) has recently shown that botanists are still as ignorant as they were in the days of LINNÉ in regard to the function of the extrafloral nectaries of plants in general. And the significance of such structures as the Beltian bodies of the acacias, the Müllerian bodies of the *Cecropias*, and the "bead-glands" of these and many other tropical plants rarely or never visited by ants, is even more obscure. The extraordinary enlargement of the thorns of the ant acacias, especially of the African species, in which they are sometimes so voluminous that the *Crematogasters* have to construct carton partitions across their cavities, in order to convert them into suitable nests, also suggests that these organs have some unknown significance in the life of the plant, quite apart from their suitability as dwellings or as supplies of food for the ants.

The whole matter becomes clearer, I believe, when we turn to the acacia ants themselves, for there can be no doubt that these are exquisitely adapted to the plants. We have seen that four of the *Pseudomyrmas* occur in no other situations, and that they

are perfect adepts at utilising the thorns as dwellings, and the nectar and Beltian bodies as food. The simplest explanation, therefore, is that these ants were formerly pandendrophilous, like the vast majority of *Pseudomyrma* species, but that they long ago discovered the greater advantage of living on the acacias, and have since confined their attention exclusively to these plants. That this adaptation may have been very easily and quickly established is shown by *Ps. gracilis* and *Camponotus planatus*, both widely distributed, and pandendrophilous ants, which in certain regions have become as completely adapted to the acacias as the obligatory *Pseudomyrmas*. On this view there is nothing any more remarkable in the predilection of particular ants for particular species of plants than there is in the predilection of particular phytophagous insects for particular host plants. Indeed, this view can be rejected only by those who are unfamiliar with the ant-life of the tropics, who have never been impressed by the vast numbers of these insects perpetually exploring the surfaces of the rank and varied vegetation in their eager search for food and habitations. No suitable cavity in the plant body, no sweet exudation, no particle of accessible food escapes their attention, and any plant that furnishes one or more of these desiderata is at once appropriated and becomes "myrmecophilous." And although it must be admitted that some of these dendrophilous ants (*Pseudomyrma*, *Azteca*) sting and bite severely, and may therefore defend the plants, this is, of course, merely a coincidence or by-product, as it were, of the true defence which the ants exercise in behalf of their own bodies and their brood. I believe, therefore, that we may adopt VON IHERING'S point of view, and say that *Acacia cornigera*, *hindsii*, and *sphaerocephala* have no more need of their ants than dogs have of their fleas. If this is true, the relation between the ants and plants is not one of symbiosis, but one of parasitism.

NOTES ON CENTRAL AMERICAN SPECIES OF CECROPIA AND TRIPLARIS.

The case of the acacias is, indeed, much more like that of the *Cecropias* than is generally supposed. Some years ago (1907)

I showed that in Porto Rico a common tree of this genus (*C. peltata*), though fully equipped with the so-called myrmecophilous adaptations (*i.e.* the hollow stems, internodal prostomia, and Müllerian bodies), is never tenanted by Aztecas, because there are no Aztecas on the island, nor, in fact, on any of the larger Antilles.¹ It is also known that some of the Brazilian *Cecropias* are free from these ants. Several species of *Cecropia* (*C. humboldtiana* Klotzsch, *insignis* Liebm., *obtusifolia* Bert., *polyphlebia* Don. Smith, *mexicana* Hemsl., and its variety *macrostachya* Don. Sm.) occur throughout Central America up to altitudes of about 3,500 ft. Some of them are really tree-weeds, which spring up in great numbers, like their herbaceous allies, our northern nettles, in all clearings. After examining hundreds of young and old trees I have come to essentially the same conclusions as VON IHERING and FIEBRIG. As young trees 3 to 6 ft. in height, the *Cecropias* contain only isolated queen Aztecas in their hollow internodes, just as the young acacias contain only isolated *Pseudomyrma* queens in their thorns, and are therefore quite as defenceless as other plants which have no thorns or stinging hairs. Nevertheless these young *Cecropias* are very rarely attacked by the leaf-cutters, and their foliage is really in much better condition than that of the older trees, in which the queens have produced hordes of belligerent workers. The foliage of such old trees is often much eaten by sloths, caterpillars, and Chrysomelid beetles or their larvæ, as has also been noticed by the observers in South America. On one occasion at Gatun, in the Canal Zone, I saw a female sloth, with a young one on her breast, leisurely devouring the large palmate leaves of a tall, ant-infested *Cecropia*. The foliage of this tree seems, in fact, to be the favourite food of these extraordinary mammals. FIEBRIG has also described complete defoliation of *Cecropias* in Paraguay by grasshoppers. These few notes will suffice to show that the famous case of these plants is no more clearly established in favour of the Belt-Delpino hypothesis than is that of the acacias.

¹ Recently I have made the same observation on the *Cecropias* which abound in the hilly regions of the provinces of Havana, Matanzas, and Santa Clara, Cuba. These trees, though closely resembling the continental species of the genus in the structure of the internodes, trichilia etc., have no ant inhabitants.

The species of the Polygonaceous genus *Triplaris* are also included among the "myrmecophilous" plants, although they are not known to bear extrafloral nectaries or food-bodies, and merely accommodate the ants with dwellings in their hollow stems. Some of the species are said to have bright red flowers, and either for this reason, or because one can hardly touch the trees without being stung by the ants, are widely known in tropical America under the name of "palo santo."

I was able to study one of the species of *Triplaris* (*T. cumingiana* Fisch. and Mey.) through the kindness of Mr. Christophersen, who guided me to several specimens growing in low, marshy ground at Frijoles on the old line of the Panama Railroad. These trees were 15 to 20 ft. high, with very slender trunk, smooth, light grey bark, and long, narrow, lanceolate leaves. When the trunk was cut down and split longitudinally, it was seen to have a very slender cavity in the centre and extending its full length, and communicating with a similar slender cavity in the centre of each branch. This continuous system of cavities communicated with the surface by numerous slender galleries, excavated by the ants, and terminating in small round orifices, which served as exits and entrances. Each tree was occupied by a single large colony of *Ps. arboris-sanctæ*, a yellow species, which is larger and stings more severely than the regular acacia *Pseudomyrmas*. As the *Triplaris* trees were isolated, and as their bases must stand in the water during the rainy season, it is difficult to understand how the ants manage to exist, unless they remain rather dormant during this season or find some hitherto unknown food-supply on the foliage.

A second and very different species of *Triplaris* (*T. macombii* Don. Smith) was seen in great numbers along the beautiful roadsides of Patulul and Escuintla in Guatemala. This is a larger tree, often attaining a height of 30 to 40 ft., with more diffuse branches and large, coarse, ovate leaves. Early in January it began to put forth bunches of long, yellowish flower-spikes, which were covered with a deciduous sheath. The branches have much larger cavities than in *T. cumingiana*, and the septa at the nodes are not broken through. On examining the surfaces of the branches, each internode is seen to be surrounded near its distal end by a circle of lenticels, and one of

these, for some unknown reason, often becomes considerably enlarged and bears a long, slit-shaped impression. It is in this impression that the queen ant makes the circular perforation that permits her to enter and take possession of the internodal cavity. This recalls the conditions in *Cecropia*, and suggests that ants may be able, through their extremely delicate tactile (or rather chordotonal) sense-organs, to select for perforation the thinnest spot in the wall of a cavity. The cavities in the branches of *T. macombii* are occupied by several species of ants belonging to the genera *Crematogaster*, *Pheidole*, *Tapinoma*, and *Iridomyrmex*, but two species are especially common, a small black, narrow-headed *Azteca*, and the black *Pseudomyrma sericea* Mayr. Colonies of all of these species may be found nesting in the internodes of the same branch, but the *Pseudomyrma* is the most abundant and aggressive. It stings quite as severely as its congeners on the acacias, but, unlike the *Ps. arboris-sanctæ* of *Triplaris cumingiana*, it does not take possession of the whole tree, to the exclusion of other species. It is, moreover, a common ant in the hollow twigs of many different trees. As *T. macombii* is a large, vigorous tree, with coarse leaves that can hardly tempt the leaf-cutters, I fail to see how it derives any benefit from its motley assortment of ant-tenants. But that the ants find the hollow internodes of the *Triplaris* the most suitable of habitations can hardly be doubted.

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PROGRESS IN OUR KNOWLEDGE OF THE ODONATA
FROM 1895 TO 1912.

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At the third International Congress of Zoology, held at Leyden, September 1895, a memoir entitled *Le Progrès dans la Connaissance des Odonates* was presented by M. le Baron EDMOND DE SELYS-LONGCHAMPS, the most eminent authority on this group of insects. For reasons which he gives, DE SELYS was obliged to limit himself to a succinct sketch of the evolution of the taxonomy of the Odonata.

The seventeen years which have elapsed since the Congress of Leyden have seen the publication of many researches dealing with the insects known as Dragonflies, Libellules, or Libellen, in three principal European languages. A Congress of Entomology seems an especially fitting occasion on which to summarise the results of these investigations. The following lines will therefore attempt a review of what seems to be the most important work done between 1895 and 1912, not only in taxonomy, but also in the other divisions of the entomology of the Odonata. A brief outline of the systematic literature from the time of LINNÆUS to the close of the nineteenth century was published by Mr. KIRBY in 1901.

Our views of the relationships of living beings to each other, of their evolution into their present forms, and of the values of the characteristics by which we judge these relationships, are changed from time to time as our knowledge of structure and ontogeny increases. During the period which we here discuss, several important contributions to the morphology and embryology of the Odonata have appeared.

MORPHOLOGY OF THE ABDOMEN AND ITS TERMINAL PARTS.

Almost at the beginning of the period stands the work of RICHARD HEYMONS, *Grundzüge der Entwicklung und des Körperbaues von Odonaten und Ephemeropteren* (1896), in which he not only made known many new facts of the embryonic development of these insects, but also demonstrated the existence of twelve segments in the abdomen of young Odonate *larvæ*, a number which up to that time had been observed only in the *embryos* of insects, and which he considers to be fundamental for the class. His results on the appendages and processes with which the body terminates were expressed in the form of a table which is reproduced here, with some slight modifications.

FATE OF LARVAL ABDOMINAL PARTS AFTER TRANSFORMATION
(*Odonata*).

+ = present. — = absent or feebly developed.

Young larvæ, all groups.	Imagines.			
	<i>Zygoptera</i> ♀.	<i>Zygoptera</i> ♂.	<i>Anisoptera</i> ♀.	<i>Anisoptera</i> ♂.
Tergite and sternite of 10th segment	+	+	+	+
Processus caudales (outgrowths of the 10th segment)	+ ("Appendages" of taxonomists)	+ ("Superior appendages" of taxonomists)	+ ("Appendages" of taxonomists)	+ ("Superior appendages" of taxonomists)
Appendix dorsalis (= tergite of the 11th segment)	—	—	+ (11th tergite)	+ ("Inferior appendage" of taxonomists)
Appendices laterales (cerci, 11th segment)	— (2-parted sternite)	+ ("Inferior appendages" of taxonomists)	— (2-parted sternite)	— (2-parted sternite)
Laminæ anales (= 12th segment)	—	—	—	—

HEYMONS emphasised again the absence of any homology between the "inferior appendages" of male *Zygoptera* and male *Anisoptera*, already pointed out by RAMBUR in 1842 (page 14). He also laid stress on his conclusion that the adult *Odonata*, other than the male *Zygoptera*, do not possess cerci, as do the *Orthoptera*, for example.

This view being questioned by HANDLIRSCH (1903) led HEYMONS to a fuller examination of the whole subject, in which (1904) he re-affirmed his previous belief, although he substituted the name "cercoids" for "processus caudales." While his statement of observed fact was accepted by HANDLIRSCH (1904), a difference of interpretation remained as to whether the "cercoids" or "superior appendages" of the adults represent newly-acquired parts not homologous with Orthopterous cerci (HEYMONS), or whether they are but reformations of true cerci (HANDLIRSCH). For myself I favour the former idea.

MATING POSITIONS AND STRUCTURES.

The consideration of the morphology of the terminal abdominal appendages of the adult Odonata naturally leads to that of their function, and while it has long been known that these parts of the males grasp the females in the act of mating, it was not until our own period that the differences in the employment of these parts in the two suborders of the Odonata were pointed out. Previous statements were to the effect that the male's appendages grasped the "neck," that is, the prothorax, of the female, but in 1899, and again in 1906, WILLIAMSON called attention to the fact that in the Anisoptera it is the **head**,¹ in the Zygoptera the **prothorax** of the female that is seized. It will be seen, therefore, that the difference in the part of the female grasped coincides with a difference in the morphology of the "inferior appendage" of the male which grasps.

TILLYARD (1909) has found that in the Australian *Petalura gigantea* both **head and mesothorax** of the female are enclosed between the male's appendages. The fact is interesting for a number of reasons. The Petalurinae are Anisoptera, and have been considered by some writers (CALVERT 1893, RIS 1896, VAN DER WEELE 1906) as, of all their suborder, nearest to the Zygoptera. This copulatory position of *P. gigantea* gives some suggestion as to the divergence in this position between Zygoptera and Anisoptera. *Petalura*, however, is a true Anisoptera in that

¹ There is, however, a recent discordant statement—that of TILLYARD (1910), who asserts that the male *Synthemis eustalacta* clasps the female's prothorax.

the single inferior appendage (appendix dorsalis of HEYMONS), of the male is applied to the dorsal surface of the female's head.

Previous to February 1899 (the date of WILLIAMSON'S *A Note on Copulation among Odonata*), systematic descriptive writers had called attention to differences in the shape and structure of the prothorax in the female Zygoptera, and referred to them as correlated with differences in the form of the male appendages, and KOLBE (1881) in particular had summed up these correlations. The list of such mutual sexual adaptations in this suborder has been increased during our period by various writers, while in consequence of WILLIAMSON'S discovery similar adaptations or lacerations on the head of Anisopterous females have been demonstrated or rendered probable, as, for example, by RIS (1910), E. M. WALKER (1912), and CALVERT (1912).

COPULATORY APPARATUS OF THE MALES.

A well-known peculiarity of the Odonata, and one which distinguishes them from all other animals except the Araneina and the Cephalopod Mollusks, is the wide separation in the male of the orifice of the ejaculatory duct from the penis and its accessory copulatory structures, the orifice lying on the ventral surface of the ninth abdominal segment, as in insects generally, the penis, etc., on the ventral surface of the second and third abdominal segments. Before copulation can occur, therefore, the sac, or vesicle, of the penis must be charged with sperm by such a bending of the male's abdomen that the ventral surfaces of its second and ninth segments may be brought in contact.

The penis and its adjacent accessory copulatory structures (described under such names as anterior lamina, vesicle of the penis, genital lobes, etc.) have been utilised for taxonomic purposes by many writers, but the investigation of the morphology of these parts lies wholly within the time under our consideration. On purely anatomical grounds Miss GODDARD (1896) suggested that hamules and penis in certain Libelluline genera are modified abdominal appendages of the second and third segments. THOMPSON, in an almost purely comparative anatomical paper (1908), did not touch on this deeper question, but sought to establish the homologies of the parts found in

different representatives of the Odonata with each other. BACKHOFF (1910) has studied the development of the copulatory apparatus in males of the genus *Agrion* (*Cænagrion* Kirby) by means of surface preparations and microtome sections, finding no trace of these structures previous to the ante-penultimate larval stage (instar); they arise from unpaired cell-masses and show no indication at any time of origin from fusion of paired rudiments, and hence cannot be homologised with the other paired segmental appendages. His summary of the differences in the apparatus of the Zygoptera and of the Anisoptera respectively may be expressed as follows:

Zygoptera (regarded as the more primitive): Penis unjointed; its lumen communicating at its basal end with the body cavity, but not with the seminal vesicle (vesicle of the penis), and without a distal aperture to the exterior; muscles, nerves, and tracheæ lacking from the copulatory apparatus.

Anisoptera: Penis jointed; its lumen not communicating with the body cavity, but continuous with that of the seminal vesicle, and having an opening to the exterior near its apex; muscles, nerves, and tracheæ present in the copulatory apparatus.

Nothing is yet known as to the details of the transference of the spermatozoa from the ejaculatory duct until they reach the female, and we are still entirely in the dark as to how the localisation of the copulatory apparatus of the male, near the anterior end of the abdomen, remote from his genital orifice, came into existence, although BACKHOFF has suggested the resemblance in position of this apparatus to that of the genital opening of the progoneate Arthropods. He infers, from the palæontological data of HANDLIRSCH (1906-8), that this localisation occurred previous to Jurassic time.

THE OVIPOSITOR: ITS DEVELOPMENT AND ITS REDUCTION.

We may turn naturally to the ovipositor of the female. The late H. W. VAN DER WEELE gave us an extended account of the *Morphologie und Entwicklung der Gonapophysen der Odonaten* in 1906. He confirmed the general results of PEYTOUREAU (1895) and HEYMONS (1896) that the gonapophyses are not the remains or vestiges of embryonic abdominal limbs, but epidermal out-

growths which first arise after the last traces of the abdominal limbs have disappeared, and in a more median position than the latter occupied. The first traces of gonapophyses, contrary to earlier statements, were found in very young larvæ or nymphs of *Agrion pulchellum* of but 2 mm. abdominal length. These traces are referred to the lateral gonapophyses of the ninth segment, and characterise both sexes. In larvæ of 3 mm. abdominal length and more, the sexes can be distinguished owing to the appearance of the first rudiments of the median gonapophyses of the same segment in the female but not in the male, soon followed by the rudiments of the anterior gonapophyses of the eighth segment in the former sex. He found rudiments of the gonapophyses in quite small *Æshnid* larvæ, but not in those of Gomphidæ, Cordulegastridæ, Cordulidæ, and Libellulidæ. While all three pairs of gonapophyses are present in the imago of the *Zygoptera*, of the *Æshnidæ* and of the *Petaluridæ* and form an ovipositor, reduction in size in the lateral gonapophyses is apparent in the latter two groups and becomes almost absent in the *Cordulegastridæ*. In the remaining *Anisoptera* the lateral and the median gonapophyses are almost, or altogether, absent, and the anterior pair show all degrees of reduction and fusion. This reduction of the gonapophyses coincides with VAN DER WEELE's idea of the higher differentiation of the *Anisoptera*. The genital pore arises originally in both sexes behind the middle of the ninth sternite, and persists in this position in the male. In the female it is shifted forward so that it has been described as at the hind end of the eighth segment.

A reduction of the female gonapophyses within a more limited group (*Synthemis*—*Corduliinæ*) has also been demonstrated by TILLYARD (1910), who has emphasised (1909) the correlation between elongated eggs and the presence of an ovipositor on the one hand, and the wider, less elongated eggs of those *Odonata* in which the female lacks such an organ, on the other.

WING VENATION.

Although the general characteristics of the wings were employed by LINNÆUS and his successors in defining the various

groups of insects, the peculiarities of venation did not receive attention until a later date. VAN DER HOEVEN (1828) was probably the first to point out the differences in the veining of the wings of different Odonata, and from his time onward there has been an ever-increasing study of this field.

It will not be, I hope, an injustice to any of the numerous investigators to credit the greatest advance in our knowledge of the wing-veins of insects to Professors COMSTOCK and NEEDHAM, whose *Wings of Insects* appeared in 1898 and 1899. Speaking as I do on English soil, I trust that I may be pardoned for a slight digression from my subject if I assume to express, on behalf of American entomologists, our deep appreciation of the honour which the Entomological Society of London conferred upon Professor COMSTOCK last November in making him one of its honorary members.

It is not necessary to linger here on the embryological method which led the two authors to the establishment of the homologies of the wing-veins throughout the class Insecta and of a common nomenclature for the highly different orders. The application of this method to the Odonata led to the realisation of the full significance of the assumption by one wing-trachea during larval life of a position posterior to that which it originally occupied, and the crossing of the radial sector, determined by this trachea, was announced as "a character quite distinctive of this order." The morphology of the arculus, the triangle, and the anal loop was also elucidated.

The subject was still further illumined by Professor NEEDHAM in his *Genealogic Study of Dragon-fly Wing Venation* (1903). This memoir advanced our knowledge of the homologies of the veins within the order, traced changes in venation from genus to genus, supplied developmental data for the determination of the values of venational characters in classification, suggested mechanical causes for the peculiarities of wings and veins, and developed ideas as to what constitute generalised and specialised conditions in these organs. No work on the Odonata within the period of our survey has had a greater influence on other investigators, due partly to the great variety of detail which the venation presents, but chiefly to the underlying method and the novelty of ideas in which the *Genealogic Study* abounds.

THE LARVA.

The great increase in our knowledge of the larvæ¹ of the Odonata is a striking characteristic of our period. As shown above, many of the authors already cited, following the embryological method, have found in the larvæ the starting-points for their special investigations and have in consequence added information on these early stages.

GILSON and SADONES (1896), and SADONES alone in a longer paper (1896), described the anatomical and histological features of the alimentary canal of the larva of a *Libellula* in greater detail than had been given previously. They supported the view that the gizzard with its teeth has a triturating and subdividing action on the bolus, although not on the food particles themselves. They described for the first time two epithelial plates or disks in the pre-rectal ampulla and a blood-cavity in the gill-plates of the rectum, and called attention to the situation of the terminal loops of the tracheoles in the subcuticular layer of cells of these gill-plates. They suggested that the absorption of oxygen from the water which is drawn into the rectum through the anus is accomplished by the vital activities of this subcuticular layer, which in turn continually delivers the oxygen as a gaseous secretion to the tracheoles; and that the oxygen is caused to pass along the tracheæ of the rectal gills and of the body by the alternate increase and decrease of the tracheal lumina. The increase was thought to be due to elongation of the tracheæ by a smoothing out of their cuticular linings, the decrease by the reverse process. The elongation and shortening of the tracheæ were referred in turn to the oscillations of cœlomic and intrarectal pressures which must accompany the respiratory movements so familiar to those who have watched living Anisopterous larvæ. On the other side of the respiratory account, the elimination of carbon dioxide was suggested to be the rôle of the blood-cavities in the gill-plates, and of the epi-

¹ In my "Introduction to the Study of Odonata" (*Trans. Amer. Ent. Soc.*, xx., p. 195 and elsewhere), I have used, in common with other writers, the term *nymph* to designate "that stage of Odonate existence between the egg and the transformation into the imago," but I do not see now why the more general term *larva* should not be employed instead.

thelial disks of the pre-rectal ampulla. It may be pointed out that this theory of larval respiration rests on anatomical and histological data, not on physiological experiments.

SADONES also called attention to the lack of correspondence in position between the rows of gill-plates of the rectum and the so-called rectal glands, as the latter alternate with the former, and to the bearing of this fact on the homologies of the rectal glands in insects generally.

CALVERT (1911) has discovered well-developed, paired, ventral, tracheal gills on a number of the abdominal segments of the larva of the Costa Rican *Cora*, one of the Calopteryginae, structures hitherto known only on a couple of Old World (Indian) genera of the same subfamily. The presence of such organs naturally suggests a very primitive condition and a point of contact with the larvæ of Ephemeridae and Sialidæ.

NEEDHAM (1897) traced the changes which occur in the epithelium of the stomach or mid-gut of larvæ during fasting and after feeding, finding in the latter case that the most turgid cells, containing presumably digestive ferments, are bodily discharged into the lumen to mix with the food and are replaced by other previously smaller cells. His results were confirmed and extended by VOINOV in the following year (1898), who showed that, previous to the actual detachment of whole cells into the lumen, clear or coloured liquids may be secreted from them. By mixing colouring matters with the food, VOINOV ascertained that the same cells which secrete these liquids also absorb material from the lumen at the same time. He traced methylene blue absorbed in this way into the body cavity and thence into many other organs, *e.g.* the developing ovaries. Other colouring matters, such as cochineal, introduced into the alimentary canal, were not absorbed, showing a selective absorptivity on the part of the intestinal epithelium. He also obtained evidence of absorption in the opposite direction, for, on injecting congo red in physiological salt solution into the body-cavity, granulations of this dye-stuff were found not only in the pericardial cells, but also in the peritrophic sac of the mid-gut lumen. Eosin, similarly injected into the body-cavity, appeared in the Malpighian tubes and in the mid-gut lumen. Only in the mid-gut was there evidence of the absorption of fats and other

soluble substances from the food, this power being possessed throughout this part of the alimentary canal and not confined to a special zone, as Cuénot had previously determined for fat absorption in Orthoptera, while fore- and hind-guts do not absorb. The peritrophic sac is apparently the inner surfaces of the epithelial cells, which become detached when these cells are in active secretion. Experimental evidence was also given for the eliminating action of pericardial cells, heart-walls, and Malpighian tubes.

That very characteristic organ of Odonate larvæ, the labium or mask, has been the subject of a special study, embryological and comparative anatomical, by Miss BUTLER (1904), from which the conclusion is drawn that the lateral lobe represents merely the labial palpus while the middle lobe is formed of laciniae and galeæ more or less consolidated in the different groups. This is essentially the theory of RAMBUR (1842) and of HAGEN (1854), in opposition to that of GERSTACKER (1873), HEYMONS (1896), and BÖRNER (1909).

LENGTH OF LARVAL LIFE.

It was not until 1909 that any definite statements existed as to the actual length of larval life and the number of moults passed through by the Odonata. In that year, BALFOUR-BROWNE gave the results of rearing *Agrion pulchellum* and *Ischnura elegans* from the egg to the imago, the first and only species for which such a complete developmental record has yet been published. He found, however, that the number of moults, consequently the number of larval stages, or instars, and the total length of larval life are not constant even in the same species. After distinguishing the form which leaves the egg and which has not free limbs as the **pronymph**, and counting as the "first nymphal" stage that which follows the pronymphal moult, BALFOUR-BROWNE found that in *Agrion pulchellum* the transformation to the imago may follow the tenth, eleventh, twelfth, or thirteenth larval (nymphal) stage. The shortest time which elapsed from hatching of the egg to the emergence of the imago in this species was 230 days; another individual occupied 634 days. The body-length in the last larval stage varied from 14

to 22 mm. He was unable to correlate the size, the number of moults, the length of larval life, and the temperatures to which the insects had been exposed, except to point out that there is a tendency "for the larger nymphs in any stage to be those which ultimately complete in the smallest number of stages." *Ischnura elegans* passed through twelve larval stages; other species of Agrionines were thought to have from eleven to fourteen. Much information is given on the rate of growth of body-length, of the antennæ, the labium, and the wing-rudiments.

BACKHOFF (1910), in the paper already quoted, estimated the number of larval stages in *Pyrrhosoma nymphula (minium)* at nine, from comparisons of the sizes of different larvæ. EAST (1900) observed the last seven moults in the larva of *Æshna cyanea* and inferred a total of nine, ten, or eleven. E. M. WALKER (1912) observed the last eight moults in Canadian *Æshna* and believes they are preceded by three or four others, making a probable total of twelve or thirteen larval stages, occupying probably three years.

CERTAIN LARVAL LIMITATIONS AND PECULIARITIES.

R. C. OSBURN (1906) conducted a series of experiments to determine the ability of eggs and larvæ of various species of Odonata to live in saline solutions of different densities, but none were able to withstand a density over 1.01. He demonstrated that there exists "a very definite barrier to their assumption of marine life, and that this barrier remains unchanged during the life of the individual."

PERKINS (see SHARP, 1895) (1899), in the Hawaiian Islands, and KNAB and CALVERT (1910, 1911), in Mexico and Costa Rica, have found that certain Agrionine larvæ (*Agrion* and *Mecistogaster* respectively) live in the small accumulations of water between leaf-bases of terrestrial and epiphytic plants, or, in the Hawaiian case, even between dry leaves. Similar habits on the part of undetermined Agrionid and Libellulid larvæ in Malaya have also been reported by LEICESTER (1903). The food of such larvæ consists of the early stages of mosquitoes, of other Diptera, etc., living in the same situations.

The discovery of Petalurid larvæ (*Tachopteryx* by WILLIAM-

SON, 1901; *Petalura* by TILLYARD 1909), and of that of *Petalia* (TILLYARD, 1910), have been noteworthy events. Those of the former group live in boggy swamps, and in the case of the Australian *Petalura* in foul, muddy ooze which cakes solidly on the larva at the time of transformation. A mud-dwelling habit is also that of the larva of the Australian *Synthemis eustalacta*, which, encased in dry mud, has been known to resist drought for ten weeks, and to fast for three months (TILLYARD, 1910).

TAXONOMY.

A comparative study of Odonate larvæ and their corresponding imagos led RIS (1896) to what may be termed the first phylogenetic classification of Odonata based on the ontogeny of an organ followed throughout the entire order. This organ was the gizzard. RIS showed that the larvæ of the Calopteryginæ and some Agrioninæ have the most complexly armed gizzard, the teeth being arranged in sixteen longitudinal folds, reduced to eight in *Lestes*, to four in *Gomphus* and *Æschna*, and further reduced to four bilaterally symmetrical *teeth* (not folds) in *Cordulegaster* and the Libellulidæ. He also showed that a reduction in the folds and in the teeth takes place in the development of the individual in each of these groups, scarcely more than traces of the teeth remaining in the imagos of the Anisoptera. Combining these results with data drawn from other organs, some of which had already been employed by previous writers, RIS presented his ideas of the relationships of the sub-families of the Odonata in the form of a genealogical tree, confessedly a modification of that of CALVERT (1893), from which it differs chiefly in placing the Cordulegastrinæ as ancestral forms of the Libellulidæ.

Both CALVERT'S and RIS'S views agreed in regarding the Zygoptera as more primitive and in looking on the Calopteryginæ as ancestral to all other Odonata. NEEDHAM, and his students Miss BUTLER and THOMPSON, whose work has been quoted above, have made many suggestions as to the generalised or specialised conditions to be found in various structures of both the Zygoptera and Anisoptera, but have refrained from formulating any detailed statement of the relationships of these

two suborders to each other, probably for the reason, as NEEDHAM himself has expressed it (1903, page 758), of not making "any suggestion that might hinder future studies."

VAN DER WEELE (1906), accepting BRONGNIART'S Protodonata as the ancestral forms of the Odonata, recognised the living *Palæophlebia* Selys,¹ of Japan, as the continuation of the Protodonata, and from the Palæophlebiidæ, as a starting-point, derived the Zygoptera on the one hand, the Anisoptera on the other.

HANDLIRSCH (1906-1908) created the term **Anisozygoptera** to include the living *Epiophlebia*, a number of Mesozoic and fewer Tertiary forms, placed it as equivalent to the Zygoptera and Anisoptera, and, like VAN DER WEELE, regarded it as ancestral to these latter two. A fourth suborder, **Archi-Zygoptera**, was also proposed for a single genus, the Mesozoic *Protomyrmeleon* Geinitz.

The Anisozygoptera present a combination of characters some of which are characteristic of the Zygoptera, such as the quadrilateral, others of the Anisoptera, as the greater breadth of the hind-wings in comparison with the anterior pair.

The great Belgian master, EDMOND DE SELYS-LONGCHAMPS, died December 11th, 1900. His wonderfully rich collection of Odonata has been placed in the Museum of Natural History at Brussels by the far-sighted wisdom and generosity of his sons, Baron WALTHER and the late Baron RAPHAEL DE SELYS-LONGCHAMPS. In pursuance of the wishes of their father, they authorised the publication of a *Catalogue Systématique et Descriptif des Collections Zoologiques du Baron Edmond de Selys-Longchamps*. This is much more than a catalogue, many of its fascicules being elaborately and beautifully illustrated monographs of the groups of which they treat.

We are concerned at present only with those fascicules dealing with the Odonata. These comprise, as far as published, one

¹ CALVERT, in a review (*Ent. News*, xiv., p. 208, June, 1903) of NEEDHAM'S *Genealogic Study*, pointed out that SELYS'S name *Palæophlebia* was preoccupied by *Palæophlebia* Brauer, and suggested *Epiophlebia* to replace SELYS'S name. Three years later, HANDLIRSCH, in *Die Fossilen Insekten*, proposed the term *Neopalæophlebia* for *Palæophlebia* Selys, but both names must fall as synonyms of *Epiophlebia*.

on the Cordulines (1906) and three on the *Æschnines* (1908-9), by M. RÉNÉ MARTIN, and five on the Libellulines (1909 onward) by Dr. F. RIS.

The fascicules on the Cordulines and the *Æschnines* are essentially expansions of DE SELYS's own publications on these groups, with the addition of such genera and species as were unknown at those earlier dates. That on the Cordulines has given rise to two attempts to establish a more natural classification of this subfamily by WILLIAMSON (1908) and by NEEDHAM (1908) respectively, based on venation, and to still further modifications, in which both larval and adult characteristics are taken into account by TILLYARD, in an excellent *Monograph of the genus Synthemis* (1910), and in later articles (1911).

The fascicules on the Libellulines represent an enormous amount of work on the part of their author, Dr. RIS, not only because of the very great number of forms which this subfamily contains, but also because of the inherent difficulties of the group itself. DE SELYS had never outlined a classification of the Libellulinæ, the only subfamily which even his long life did not enable him to reach. Although BRAUER (1868), KIRBY (1889), and KARSCH (1890) had revised the genera from time to time, no one had attempted to describe all the species and refer them to their genera in one monographic treatment. This is the task which Dr. RIS has on his hands and for which he receives the hearty thanks of Odonatologists everywhere.

It is of interest here to point out that the starting-point for the arrangement of the genera within the Cordulinæ by NEEDHAM (1908), and within the Libellulinæ by RIS in the work just noticed, is the similarity of form and venation in fore- and hind-wings, a point of view not taken in DE SELYS's work.

Other articles in which some of the larger features of the classification of the Odonata have been considered are those of CALVERT (1902) on *Zygoptera*, NEEDHAM and HART (1901) on the *Æschnidæ* (*sensu Selysii*), NEEDHAM's reports (1901, 1903) on the *Aquatic Insects of the Adirondacks*, TILLYARD in his *Synthemis* monograph (1910) already quoted, and MARTIN's *Æschnines* (1911) in the *Genera Insectorum* of WYTSMAN.

The taxonomic study of the larvæ has also made great progress, and the number of species whose early stages have been dis-

tinguished is very great as compared with those so known in 1895. For this advance we are principally indebted to NEEDHAM (1901-1903, etc.) for North America, LUCAS (1900) in England, ROUSSEAU (1908, 1909) in Belgium, RIS (1909) for Switzerland and Germany, and TILLYARD in Australia. These specific identifications were chiefly made by actual rearings of larvæ to the imago. By microscopic examination of the rudimentary larval wings, NEEDHAM (1904, etc.) has been able to recognise the venational peculiarities of the future adults, and to determine the species by this method, which has been employed by other students also.

FOSSIL ODONATA.

MEUNIER has photographically figured (1896-1898) a number of specimens from European museums, and COCKERELL (1907, 1908) has made known some interesting forms from Florissant, Colorado; but for the chief advance in this field, we are indebted to the voluminous handbook of HANDLIRSCH, *Die Fossilen Insekten* (1906-1908), of wide-reaching view, from which we have already quoted in dealing with the classification of the Odonata. HANDLIRSCH enumerates nine species of Paleozoic Protodonata from the Upper Carboniferous and the Permian of Europe (no Odonata being known from this series of rocks, nor are the Protodonata known from any later epoch), and of the Odonata proper, sixty-seven Mesozoic and ninety-two Tertiary species.

The Protodonata are considered to be ancestral to the Odonata and derivable from the still more ancient Palæodictyoptera, from which latter they differ by the narrower inter-alar tergites, the fusion of the basal parts of some of the longitudinal veins of the wings, the transformation of many longitudinal veins into so-called interposed sectors which apparently arise from cross-veins, and the presence of numerous, more regularly arranged, straight cross-veins.

On the other hand, the Protodonata differ from the Odonata by the lack of nodus, of pterostigma, and of the crossing of the radial sector over the first two branches of the media.¹

¹ This last difference is denied by SELLARDS (1906).

A further advance in our understanding of the fossil Odonata, due to HANDLIRSCH, is in placing the Mesozoic forms in genera distinct and separate from those to which they had been referred previously. Their previous positions, as summed up in KIRBY's Catalogue of 1890, gave the false impression that many of our living genera reached backward to the Jurassic.

FAUNAL STUDIES.

Time and space forbid us to do more than mention the larger and more comprehensive papers or series of papers which have appeared in this division of the subject. The general distribution of Odonata throughout the world was summarised by CARPENTER in 1897. LUCAS (1900) has given us a volume on British Dragonflies, TÜMPEL has included the central European species in his *Geradflügler Mitteleuropas* (1898-1900), and FRÖHLICH (1903) has produced a work of similar scope for Germany, and KOHAUT (1896) for Hungary. RÖSSLER (1900), DZIEDZIELEWICZ (1902), PUSCHNIG (1905-1908), and STROBL and KLAPALEK (1906) have treated in considerable detail of the Odonate fauna of various parts of the Austrian Empire. For Italy are the memoirs of GARBINI (1897) and BENTIVOGLIO (1897-1908). NAVAS (1905-1910) has furnished much information for the Iberian peninsula, while the dragonflies of Russia, Siberia, and other parts of Palearctic Asia are receiving attention from BARTENEV (1908-1912), whose papers, being in the Russian language, are unfortunately sealed to most of us. PETERSEN (1905-10) is the principal worker on the Scandinavian representatives of the Order.

For the Oriental region we have the series by KRÜGER on *Die Odonaten von Sumatra* (1898-1902), and papers by FOERSTER (1896-1905), KARSCH (1900), LAIDLAW (1902-1907), WILLIAMSON (1904, 1907), MORTON (1907), and NEEDHAM (1909) on other subdivisions.

The Ethiopian region has attracted much attention, and there are many memoirs by DE SELYS (1896-8), CALVERT (1896-8), KARSCH (1896, 1899), KIRBY (1896, 1900, 1909), FÖRSTER (1897-1909), SJÖSTEDT (1899), MARTIN (1900-08) and GRÜNBERG (1902-1903).

MUTTKOWSKI has given us a Catalogue (1910) of the Odonata of North America. KELLCOTT, HARVEY, NEEDHAM, WILLIAMSON, CURRIE, HINE, and MUTTKOWSKI have been the principal writers on the dragonflies of the United States, E. M. WALKER on those of Canada, the last-named having just published an admirable monograph on the Nearctic *Æshnas* (1912).

For Mexico and Central America is the Neuroptera volume of the *Biologia Centrali-Americana* by CALVERT (1901-08), the same author having also written extensively (1895-1912) on Neotropical Odonata, but especially on those of the province of Matto Grosso, Brazil. Important papers on South American forms are those of RIS (1904, 1908) and of FÖRSTER (1903-1910).

The last-named has also published much on the Australasian fauna, especially New Guinea, while in Australia itself TILLYARD (1906-1912) has given us a wealth of interesting observations on habits as well as taxonomic and distributional data. Among the last must be mentioned the discovery in New South Wales of a species of *Phyllopetalia*, a genus of large dragonflies hitherto known from Chile only; of the existence of so many species of the Corduliinæ as to amount to two-ninths of the total number credited to this subfamily (*sensu Selysii*) throughout the world, and representing fourteen genera out of a total of thirty-six. He has also brought forward evidence (1910) that the distribution of Australian Odonata on the whole is distinctly adverse to the acceptance of D. S. JORDAN's law, viz.: "Given any species in any region, the nearest related species is not to be found in the same region, nor in a remote region, but in a neighbouring district separated from the first by a barrier of some sort, or at least by a belt of country, the breadth of which gives the effect of a barrier." In the *Fauna Hawaiiensis*, PERKINS (1899, 1910) has described the Odonata of these interesting islands.

In such a survey as this, it is proper to notice the deaths of DAVID S. KELLCOTT, on April 13th, 1898, and of FRANCIS LE ROY HARVEY, on March 6th, 1900, who added much to our knowledge of the Odonata of Ohio and of Maine, respectively.

We have already alluded to the decease of Baron EDMOND DE SELYS-LONGCHAMPS. Two other entomologists of high repute must be numbered among the Odonatologists who passed away during the period under review—ROBERT M'LACHLAN, who died

May 23rd, 1904, and FRIEDRICH MORITZ BRAUER on December 29th, 1904. The principal entomological work of both lay outside the Odonata, although BRAUER did more synthetic work in this order than M'LACHLAN, especially on the Libellulinae; but both have left their impress on the taxonomic and faunistic literature. ALPHEUS S. PACKARD, who died February 14th, 1905, was still less deeply concerned with the Odonata, but he was a distinguished entomologist, and he is to be remembered for his morphological work on the thoracic sclerites and the ovipositor of the dragonflies. Still more recently have we had to record the deaths of H. W. VAN DER WEELE on August 29th, 1910, and of SAMUEL H. SCUDDER on May 17th, 1911. VAN DER WEELE'S work has already been noticed; Dr. SCUDDER wrote on the Odonata of the White Mountains of New Hampshire and of the Isle of Pines, before he began those palæontomological studies which have so largely contributed to his reputation, and which included careful original accounts of American Tertiary Odonata.

In conclusion, what has chiefly contributed to the progress of Odonatology during the period under review is the application of the developmental method as a means of tracing the origin, and so comprehending the significance, of the various parts of the Odonate's body. If the application of this method to these insects seems to students of other animal classes to have been slow, the excuse must be the great number of insect forms, the consequent great mass of detail to be mentally digested, and the relatively smaller number of investigators.

(In order not to unduly extend this paper, no bibliography is appended. The dates placed after each author's name will enable any one desiring to consult the original memoirs to find them by referring to the *Concilium Bibliographicum*, the *Zoological Record*, or the *International Catalogue of Scientific Literature, Zoology*, for the appropriate years.)

PROTEST GEGEN DIE ZULASSUNG VON AUSNAHMEN VOM PRIORITÄTSGESETZ.

VON WALTHER HORN, BERLIN-DAHLEM.

DER Titel des Vortrages mag im ersten Augenblick den Anschein erwecken, als stände ich auf der äussersten Seite jener Partei, welche "absolute Priorität" für das einzig seligmachende Prinzip erklärt. Dem gegenüber betone ich zunächst, dass ich im Titel ausdrücklich nur von "Ausnahmen vom Prioritätsgesetz," nicht von "Ausnahmen von der Priorität" spreche. In dem jetzt herrschenden Prioritätsgesetz besitzen wir ja schon 2 Ausnahmen von der Priorität, indem (1) alle Namen vor 1758 und (2) alle nicht-binären Namen ungiltig sind. Es stände nach meiner Ansicht wohl schwerlich ein stichhaltiger Grund dem entgegen, dass wir eine dritte Beschränkung einführten, z. B. die der Verjährung. In diesem Sinne *liessen* sich also meine Anschauungen sehr wohl mit jenem neuerdings wieder vom Rev. G. WHEELER gemachten Vorschlag in eine gewisse Übereinstimmung bringen, welcher dahin geht, dass man z. B. Namen, welche 25 oder 50 Jahre hindurch allgemein anerkannt gewesen sind, für immer gelten lässt. Persönlich muss ich allerdings bemerken, dass ich nicht die Überzeugung habe, dass wir durch eine solche dritte Beschränkung besseren Zeiten entgegengehen würden. Zweifellos haften unserem jetzt giltigen Prioritätsgesetz ja Nachteile an, und wäre es sehr erfreulich, wenn wir dieselben beseitigen könnten. Die Zahl jener Gattungen, welche wohl jeder Entomologe gern als unabänderlich angesehen wissen möchte, während sie nach dem jetzigen Kodex fallen müssten, ist aber alles in allem genommen äussert klein. Diesen der Zahl nach so geringen Nachteilen gegenüber laufen wir Gefahr, durch Einführung einer Verjährungsfrist viel zahlreichere Schattenseiten einzuheimsen, denn noch kann niemand zur

Zeit übersehen, zu was für Konsequenzen eine auch sehr vorsichtig gewählte Verjährung führen könnte. Der Begriff "25 Jahre allgemein anerkannt" ist scheinbar klar und einfach. Wie nun, wenn man hinterher findet, dass in 1 oder 2 Büchern innerhalb der Verjährungsfrist ein anderer Name zu lesen steht? etc. Aber man könnte ja einmal den Versuch machen und die Nomenklatur-Kommissionen auf dem Papier die Konsequenzen einer derartigen "Verjährung" ausarbeiten lassen. Das Schlimmste ist, gleich mit derartigen revolutionären Gesetzen unübersehbare Neuerungen *einzuführen*: die Folge wäre nur, dass immer mehr (und gerade der besten Entomologen) den Nomenklatur-Fragen verächtlich den Rücken kehren.

Persönlich bin ich ein Anhänger des jetzigen Prioritätsgesetzes, nach welchem ausnahmslos bis zum ältesten *sicher feststellbaren* Namen zurückgegangen werden müsste (binäre Nomenklatur und "1758" vorausgesetzt). Danach weiss ich wenigstens, dass nur sehr wenige Namen Anstoss erregen und dass die Zahl der alten zu verändernden Namen von Jahr zu Jahr abnehmen muss. Ob wir "so wenig geschunden" bei einer "Verjährung" davon kommen würden, ist mindestens zweifelhaft.

Beide bisher erörterten Anschauungen haben das Gemeinschaftliche, dass ein Prioritätsgesetz gefordert wird, dem alle Namen ausnahmslos unterstellt werden. Im Gegensatz dazu steht jene Richtung, welche den auch im politischen Leben wohlbekannten Boden der "Ausnahmegesetze" betreten will. Wie man die Sozialdemokratie oder die Polen durch solche gegen die bestehenden Gesetze verstossenden Paragraphen treffen oder die Agrarier schützen will, so will man bestimmte eigentlich gültige Namen verstossen und andere ausnahmsweise bevorzugen. Um das Unrecht, das damit gerade den alten Autoren zugefügt wird, kümmert man sich nicht. Gegen *diese Sondergesetzgebung* richtet sich mein Protest! Die äussere Veranlassung gibt wir der Umstand, dass gerade in Deutschland (wir können sogar direkt sagen "Berlin") in den allerletzten Monaten eine dreifache Agitation grössten Stiles für diese Ausnahmegesetze wachgerufen ist, welche aufs deutlichste zeigt, in was für uferlose Zustände wir Gefahr laufen hineinzugeraten.

Ich gebe im folgenden zunächst den Wortlaut jener Anträge zur Einschränkung des Prioritätsgesetzes, welche von der "Deut-

schen Zoologischen Gesellschaft" auf ihrer diesjährigen Versammlung in Halle a/S. en bloc angenommen sind, und für welche Herr Prof. A. BRAUER (Direktor des kgl. zool. Museums zu Berlin) die Propaganda übernommen hat, mit der Absicht, dem IX. Internationalen Zoologen-Kongress, 1913, die Annahme dieser Anträge zu empfehlen. In der Propaganda ist gesagt, dass derartige Anträge ein Jahr vor dem nächsten Internationalen Kongress, also vor dem 1. August, 1913, in den Händen der Internationalen Nomenklatur-Kommission sein müssten. Die Anträge lauten:

"§ 1. Nach dem Beispiel der Botaniker sind Listen von Gattungsnamen aufzustellen, die dem Prioritätsgesetz nicht unterliegen sollen, niemals abgeändert oder auf andere Gattungen übertragen werden dürfen.

"Diese Listen sind von besonderen Kommissionen fort-dauernd zu ergänzen.

"In erster Linie haben sie diejenigen Gattungsnamen zu enthalten, welche vor 1900 eingebürgert waren und besonders im Unterricht gebräuchlich sind.

"Als Beispiel für die aufzunehmenden Namen möge die folgende kleine Liste dienen:" (es werden 43 Genera angeführt, darunter 2 Insekten-Gattungen und zwar: Hymenoptera *Anthophora* (nicht *Podalirius*) und Orthoptera *Periplaneta* (nicht *Stylopyga*).

"§ 2. Die Übertragung eines Gattungs- oder Artnamens auf eine andere Gattung oder Art ist unzulässig, wenn sie dauernd zu Verwirrung und Irrtümern Anlass bietet.

"§ 3. Bei der Feststellung der Priorität sind gewisse Werke nicht zu berücksichtigen, z. B. [es werden 12 Werke angeführt, davon 2 entomologische: J. G. MEIGEN, "Nouvelle classification des mouches à deux ailes (Diptera L.)," Paris, 1800, und GEOFFROY, "Histoire abrégée des Insectes qui se trouvent aux environs de Paris," 1762]. Diese Liste ist von den Kommissionen zu ergänzen.

"§ 4. Ebenso wenig kommen bei der Feststellung der Priorität in Betracht: Angaben in Enzyklopädien, populären Reisewerken, Jagd- und Fischereizeitungen, Katalogen, Gärtnerzeitschriften, landwirtschaftlichen Veröffentlichungen, Unterhaltungs- und politischen Zeitschriften, Zeitungen und ähnlichen nichtwissenschaftlichen Veröffentlichungen, welche keinen wesentlichen

Einfluss auf die wissenschaftliche Systematik gehabt haben und von dieser so gut wie nicht berücksichtigt sind."

Bevor ich auf diese Vorschläge eingehe, muss ich einen Einwurf, der möglicherweise gemacht wird, im voraus zurückweisen, nämlich den, dass diese Vorschläge "nicht wörtlich" zu verstehen sind, sondern "anders gemeint" wären. Mich lässt dieser Einwurf kalt! Wer sich dazu berufen fühlt, Gesetze zu machen oder vorzuschlagen, muss meiner Meinung nach zum mindesten 2 Vorbedingungen erfüllen, d. i. (1) streng logisch denken können und (2) fähig sein, seine Gedanken in seiner Muttersprache exakt auszudrücken! Wenn ich in einer Neubeschreibung sage, dass ich 1 ♂ von 22 mm. Länge vor Augen habe, und es stellt sich nacher heraus, dass es 1 ♀ von 18 mm. Länge gewesen ist (ähnliche Fälle sind ja leider vorgekommen!), so habe *ich* die Folge dieser Konfusion verschuldet, nicht derjenige, der meine Angaben nach den Begriffen der einfachsten Logik behandelt. Wir haben uns also an den *Wortlaut* der gemachten Vorschläge zu halten, auch wenn wir es kaum für glaublich halten können, dass eine wissenschaftliche Gesellschaft die Absicht gehabt, solche Anschauungen zu vertreten. Jeder andere Standpunkt liesse der Phantasie und der Willkür freien Lauf.

Betreffs § 1 der Vorschläge verweise ich auf das zu Anfang Gesagte und bemerke nur, dass der I. Internationale Entomologen-Kongress in Brüssel (1910) sich in seinen Nomenklatur-Vorschlägen (N. 7) für die absolute Durchführung des Prioritätsgesetzes ausgesprochen hat. Sonst wäre wohl gegen den ersten Paragraphen für sich allein¹ als "Ausdruck einer vertretbaren Anschauung" nichts einzuwenden.

Ganz anders steht es mit den folgenden Paragraphen.

Zunächst § 2. Von dem nicht gerade geschickt gewählten Wortlaut sehe ich ab. Ich begnüge mich damit, auf eine einzige Konsequenz aufmerksam zu machen: Jeder lange Zeit hindurch auf ein und demselben systematischen Gebiet tätige Entomologe, z. B. also jeder führende Spezialist, kann danach (allein oder mit

¹ Ganz anders, wenn man § 1 mit § 4 zusammen betrachtet. § 1 ist für Konservierung der im Unterricht gebräuchlichen Gattungsnamen (z. B. eines landwirtschaftlich-entomologischen Hand-Buches). § 4 will alle Namen in "landwirtschaftlichen Veröffentlichungen" nomenklatorisch für ungültig erklären!

einigen Anhängern) durch konsequentes Protestieren gegen eine von anderer Seite vorgeschlagene Aenderung (z. B. durch konsequentes Ignorieren eines alten Namens und Beibehalten des neueren) willkürlich eine "dauernde Verwirrung" schaffen, die ihn oder seine Anhänger dann hinterher berechtigen würde, den fraglichen Namen als unzulässig erklären zu lassen. Wer weiss, wie starr viele Entomologen an einmal gefassten Meinungen festhalten, muss diese Gefahr ohne weiteres würdigen.

Ad § 3. Es wäre an sich gewiss zu begrüßen, dass Werke, *welche nicht den Nomenklaturgesetzen entsprechen* (oder zum mindesten in diesem Punkte zweifelhaft sind) als solche an prominenter Stelle gekennzeichnet würden, wodurch eine erfreuliche Aufklärung möglich wäre. Wenn aber statt dessen gewisse Werke ohne jede weitere Erklärung für ausserhalb der Priorität stehend erklärt werden, so können diese Listen gar zu leicht den Charakter von Proskriptions-Listen bekommen.

§ 4 ist der beste Beweis für die eben angeführte Gefahr. Seine Befolgung würde geradezu ein Elend für die systematische Entomologie bedeuten. Ganze Klassen von Veröffentlichungen werden da "ganz waschecht" proskribiert! Zunächst alle (also auch die wissenschaftlichen) Enzyklopädien. Im folgenden eine kleine Blütenlese solch' geächteter Werke:

"Encyclopédie méthodique," Latreille, Olivier, Godart, Serville, Le Peletier!

"Dictionnaire d'Histoire Naturelle de Déterville" und "Nouveau Dictionnaire d'Histoire Naturelle Déterville," Latreille.

"Dictionnaire classique d'Histoire Naturelle," Latreille.

"Dictionnaire pittoresque d'Histoire Naturelle" und "Nouveau Dictionnaire classique d'Histoire Naturelle," Guérin.

"Dictionnaire des Sciences Naturelles," Duméril.

"Magasin encyclopédique Millin," Cuvier.

"Brewster Edinburgh Encyclopædia" und "Encyclopædia Britannica," Leach, Wilson, etc.

"Encyclopædie Ersch und Gruber," Germar, etc., etc.

Die angeführten Autorennamen sollten genügen, um bei dieser Forderung jeden wissenschaftlichen Entomologen erröten zu lassen.

Dann folgt die Proskription der populären Reisewerke. Was heisst "populäre Reisewerke"? Wo soll die Grenze gegenüber

den "wissenschaftlichen Reisewerken" gezogen werden? Vielfach handelt es sich dabei nur um die Begriffe des buchhändlerischen Erfolges: wenn letzterer sehr gross ist, läuft also der Autor um so grössere Gefahr, dass seine Beschreibungen als vogelfrei (im nomenklatorischen Sinne!) erklärt werden. Sonderliche Welt! Was mag man wohl mit jenen zahlreichen allgemein verständlichen Reisebeschreibungen machen, welche einen wissenschaftlichen Anhang oder etwas Ähnliches besitzen (z. B. Walzl "Reise durch Tyrol . . . nach dem südlichen Spanien"). Gesetze sollten solche unklaren Vorstellungen denkbarst meiden.

Ganz eigenartig wirkt die Proskription der "landwirtschaftlichen Veröffentlichungen." Also alles, was in den wissenschaftlichen Agricultur-Zeitschriften von U.S.A., Canada, Indien, Australien, etc., publiziert worden ist und noch veröffentlicht wird, ist nomenklatorisch ungiltig?—Wohl verstanden, dass alles ist nicht nur in *mündlicher* Verhandlung (wo oftmals ein Satz fällt, der hinterher eine Korrektur verträgt) gefordert worden: Es ist *geschrieben, gedruckt* und durch eine *Propaganda grossen Stiles hinterher noch bestätigt worden*. Der Direktor des grössten Institutes für systematische Zoologie in Deutschland hat diese Propaganda übernommen.

Genau so absonderlich mutet der Nomenklatur-Ausschluss der "Kataloge," an, wonach selbstverständlich auch alle Namen in wissenschaftlichen Katalogen ihre Prioritätsberechtigung verlieren, denn zu den "Katalogen" gehören nicht nur Händler-Preislisten (Wortlaut von Brüssel!). Im folgenden einige wenige Beispiele von so proskribierten Katalogen:

"Catalogus Coleopterorum," Gemminger & Harold.

"Coleopterorum Catalogus," Junk-Schenkling (grösster Special-Katalog des Tierreichs!).

"Catalogus Coleopt. Europ. 1906," v. Heyden, Reitter, Weise.

"Catalogus Hymenopter.," Dalla Torre.

"Catalog der Lepidopteren der Paläarktischen Fauna," Staudinger & Rebel.

"Lepidopter. Catalogus," Wagner (Aurivillius).

"Synonymic Catal. of Diurnal Lepidoptera and Lepidoptera Heterocera," Kirby.

"Catalogue of the Lepidoptera Phalæna," Hampson, etc., etc.

Da eine retrospektive Wirkung nicht ausgeschlossen wird, fallen durch dies *eine* Wort *Tausende* von bisher giltigen Namen !

Gegen die Ausdrücke "Jagd- und Fischereizeitungen," "Gärtnerzeitschriften," "Unterhaltungs- und politische Zeitschriften, Zeitungen und ähnliche nichtwissenschaftliche Veröffentlichungen, welche keinen wesentlichen Einfluss auf die wissenschaftliche Systematik gehabt haben und von dieser so gut wie nicht berücksichtigt sind" wird mancher im ersten Augenblicke weniger Bedenken haben. Bei etwas eingehenderer Prüfung sieht es aber auch dabei mit den logischen Konsequenzen böse aus. Zunächst deshalb, weil auch hier die retrospektive Wirkung nicht ausgeschlossen ist ; dazu kommt die Unklarheit der Fassung des Relativsatzes "welche keinen . . ." Was heisst "wesentlich" ? Giebt es eine "unwissenschaftliche Systematik" ? Wo liegt die Grenze von "so gut wie nicht berücksichtigte" ? Wer will darüber entscheiden ? Etwa Majoritätsbeschlüsse von Kommissionen ? "Unterhaltungs- und politische Zeitschriften" klingt gewiss unverdächtig ; doch man denke an die alte Oken'sche "Isis" (deren eine Nummer sogar seinerzeit konfisziert gewesen ist : sie nannte sich übrigens selbst eine "encyclopädische Zeitung" und wimmelte voller Entomologie !). Ferner fällt auf, dass der Ausdruck "Forstwissenschaftliche Veröffentlichungen" fehlt, da man ja *neben* dem allgemeinen Ausdruck "Landwirtschaftliche Veröffentlichungen" die "Fischereizeitungen," "Gärtnerzeitschriften," etc., extra anführt. Hat man sie nur zufällig fortgelassen oder will man sie auf eine höhere Stufe stellen als jene anderen und deshalb nomenklatorisch anerkennen ? Es gab eine Zeit—sie ist leider vergangen—wo die deutsche Forstentomologie die Führung in der ganzen Welt hatte !

Man mag gegen alles bisher Vorgebrachte vielleicht einwenden, dass trotzdem die Hallenser Anträge unschädlich seien, da sie erst im Juli der Internationalen Nomenklatur-Kommission unterbreitet worden sind, während der Internationale Kongress schon im März in Monaco stattfindet. Damit wäre jedoch höchstens ein Aufschub gewonnen. Leider haben aber die Hallenser Vorschläge schon jetzt ihre trüben Folgen gezeitigt, indem sie 2 deutsche entomologischen Gesellschaften die "Deutsche Entomologische Gesellschaft" und den "Berliner

Entomologische Verein" (beide in Berlin) veranlasst haben, sofort folgende "*Beschlüsse*" zu fassen:

"Die D. E. G. und der B. E. V. stehen auf dem Standpunkt, dass alle Encyclopädien, Reisewerke, Jagdzeitungen, Kataloge, Gärtnerzeitschriften, landwirtschaftliche Veröffentlichungen, Unterhaltungs- und politische Zeitschriften, Zeitungen und ähnliche nichtwissenschaftliche Veröffentlichungen, welche bisher in der wissenschaftlichen Systematik nicht berücksichtigt worden sind, auch in Zukunft bei der Feststellung der Priorität nicht berücksichtigt werden dürfen."

Bei dieser gekürzten und entstellten Fassung ist der Sinn noch merkwürdiger geworden. Alle wissenschaftlichen Reisewerke der Zukunft werden proskribiert! etc. Doch ich will nicht weiter darauf eingehen, wohin dieser "*Beschluss*" führen würde.

Videant Consules! man ging von dem berechtigten Wunsche aus, ein paar Gattungsnamen schützen zu wollen—man proskribiert ganze Kategorien von Publikationen—man gefährdet Tausende (vielleicht Zehntausende!) von bisher giltigen Namen—man erklärt praenumerando eine ungeheure Masse von doch sicher erscheinenden Werken für nomenklatorisch rechtlos. Ich hoffe, dies Beispiel ruft zur Besinnung, mag man mit den obigen "*Vorschlägen*" und "*Beschlüssen*" *gemeint haben, was dieselben wörtlich sagen, oder nicht.*

ON THE PLACE OF FIGURES IN DESCRIPTIVE ENTOMOLOGY.

By LOUIS B. PROUT, F.E.S.

It is matter of common knowledge among lepidopterists that Monsieur CHARLES OBERTHÜR has for years been strenuously advocating the view that a figure or picture of the butterfly or moth is not only a desirable addition to the diagnostic matter by which a new species is made known, but a *sine qua non* ; indeed, not only a *sine qua non*, but *the sine qua non*. And it is as a natural outcome of that strenuously advocated view that the present Congress is asked to consider the passing of a law refusing validity to any new name which is not accompanied by a "good figure." As the question—particularly in the aspect which is presented by M. OBERTHÜR'S treatment of it—is one of considerable gravity, and some of the important issues raised have not, or scarcely, been discussed in public, I feel it incumbent on me to offer a small contribution to the subject.

It is perhaps almost superfluous to say, at the very outset, that the question is purely impersonal, and that if I am compelled repeatedly to refer to M. OBERTHÜR by name, and to his own work, this is only because he and it are the embodiments of the principle which is before us for consideration. I am above all things solicitous that nothing which I may have occasion to say, either here or elsewhere, shall seem to detract from the esteem and admiration which I feel for that prince of lepidopterists, and for his exquisite *Études*. The position is a rather delicate one, as the proposal which I have to attack is so dear to the heart of my friend ; but I am emboldened by the eminently sane attitude which he has taken in his correspondence with me on this matter, and I am sure I am guilty of no breach of confidence, if I quote from one of his letters, in order most heartily to endorse the view—that

"we may hold the most strongly divergent opinions and yet remain good friends."

I have already stated in an earlier note ¹ that I fully recognise the value of illustrations as a supplement to the descriptive matter—always provided the illustrations be accurate enough to prove a help rather than a hindrance, and that the author of the species is willing to make himself responsible for them. The latter proviso is essential, for the author is rarely his own artist, and cases are on record in which he has absolutely repudiated the "illustrations": in such an event any increased value set on them by the laws or principles of nomenclature is merely a delusion and a snare. But speaking generally, I believe we may reasonably hope for unanimity in the affirmation of the principle of the utility of illustrations, and even in a definite resolution recommending to authors a larger use of such helps.

Beyond this I feel we cannot go without injury to the best interests of the science. This may appear a strong statement to make, but I base it on well-considered reasons, which I shall proceed to set forth to the best of my ability. But first let me point out—as I have already in part done in the note above referred to ²—that the advocacy of "illustrations" is a totally different thing from adhesion to M. OBERTHÜR's idea, even in any less drastic form than his own. In my early entomological days, lepidopterists were, I remember, somewhat looked down upon by the students of other insect orders for their comparative neglect of structural characters in their studies; but surely we have long outgrown the days when we thought that a butterfly or moth had no important parts but its wing-scales, and have come to recognise, in common with our brother-entomologists, that the *entire* morphology of an insect has a bearing, even on its identification, to say nothing of its classification. At any rate, even if we lepidopterists are still somewhat behind the times, being subverted from more strictly scientific paths by the wonderful variety of colour and pattern displayed by our favourites, it is inconceivable that a Congress of *Entomologists* (not "Lepidopterists") will regard "illustration" as signifying merely a sort of bird's-eye view, so to speak, of the insect as seen from

¹ *Ent. Record*, xxiii., 264.

² *Ibid.*, 263-5.

a single aspect, or at most from two. The way to elucidate a new species by illustration is to illustrate just the character or characters which will best differentiate it from its already known allies. It would be easy to cite scores of examples in the Lepidoptera, and to our coleopterist and other friends similar cases would occur in thousands. I will content myself with two or three from the *Geometridæ*. In Dr. A. J. TURNER's recent masterly revision of the Australian *Sterrhinæ* = *Acidaliinæ*,¹ which as a matter of fact is entirely unillustrated, but by means of which I am able to work out my material with a precision for which I could never hope from the Acidaliid figures in, let us say, the *Biologia Centrali-Americana*, various species (e.g. of *Leptomeris*) are differentiated by the male hindtibial structure; for instance, *L. thysanopus* Turner, n. sp., is distinguished from *L. optivata* Walk., by "posterior tibiæ of male more strongly dilated in basal half, with two tassels at base." If an illustration is to be demanded—which is really superfluous—let me implore, in the name of common sense and practical utility, that it should be a figure of an enlargement of the male hindtibia, and not a drawing of the wing-area, for which TURNER has been able to bring out no more momentous differentiation than "absence of blackish scales from cilia"—likely enough to be missed by even the most careful artist if he were asked to draw figures of the two species in question, on which posterity was to depend. In my own paper on the *Geometridæ* of the Argentine Republic² I described and figured a species *Salpis rubens*, and described but did not figure a very close ally, *S. carneitincta*; had I figured it, I feel sure that three out of four students of the plate would not have been able to name their specimens from it—which, if I may be permitted to say so, seems to be the matter of supreme importance in M. OBERTHÜR's estimation; but a few words of description of the distinctions in the antennal ciliation have rendered differentiation certain, and if I were called upon to furnish an illustration (again "really superfluous"), I should certainly give drawings of a few joints of the antenna, strongly magnified. The same remarks apply to *Craspedia deserta* Warr.,³ in its less

¹ *Proc. Linn. Soc. N. S. Wales*, xxxii., 635-98.

² *Trans. Ent. Soc. Lond.*, 1910, pp. 204-345.

³ *Novit. Zool.*, iv., 51.

reddish forms, and *C. dissonans* Warr.,¹ and to various other pairs of close allies.

Perhaps, in referring to the thousands of such cases which would occur to the coleopterist, I shall be told that I am beating the air, and that M. OBERTHÜR has no thought or intention that his rule should apply beyond the ranks of the lepidopterists.² As I am very strongly opposed to any divergence in the nomenclatorial laws of entomologists from those of zoology in general, it follows *a fortiori* that I could not for a moment entertain the idea of a law for lepidopterists alone; but I am quite willing, for the remainder of this paper, to confine my attention to the lepidopterist's point of view.

The only argument against "figures" (in M. OBERTHÜR's sense) which I have yet seen brought into much prominence is that of their expense. So M. OBERTHÜR himself,³ Mr. G. T. BETHUNE-BAKER,⁴ M. P. DOGNIN,⁵ and others. This is by no means an unimportant argument, although, as Dr. CHAPMAN points out,⁶ photography has done much to reduce its cogency. Still, the delaying of the working out of the large accumulations of material with which modern travel and research are providing us, even until photographic illustrations of all could be procured, would be a real hindrance to scientific progress. But the question of "l'argent" is by no means the only, nor even the chief argument against the disproportionate insistence on "good figures." The expense of illustration could with time and patience be met, the world's fauna could in the meantime be made known more slowly, and the systematist, or student of geographical distribution, could for a few generations longer take a back seat or be content to work on much more meagre material, however tantalising it might be to him to know that there were thousands of species waiting in the large collections which *might* have been available in his survey but that they remained zoological nonentities. But the real

¹ *Novit. Zool.*, iv., 51.

² *Ét. Lép. Comp.*, v. (1), p. xxxi.

³ *Ibid.*, pp. xxxi, xxxii, etc.

⁴ *Ent. Record*, xxiii., 271.

⁵ *Ann. Soc. Ent. Belg.*, lvi., 136.

⁶ *Ent. Record.*, xxiii., 239.

mischief would remain unchecked ; I think we may even affirm that it would grow the faster in proportion as the facilities for cheap illustration were increased. The fight—at least as it is presented to us in the existing controversy—is one between scientific and picture-book entomology. I yield to no one in my admiration for picture-book entomology, especially when it is of such a superb order as that of the illustrative portions of the *Études de Lépidoptérologie*, verily things of beauty which I trust the hand of Time, working through the subtleties of chemical action, will allow entomologists to retain as “a joy for ever.” But I have always been taught that language, and not picture, was the recognised medium for the conveyance of precise knowledge, and I protest against any attempt being made to undermine so vital a principle of science.

At the risk of repetition I here interject that ideally we *could* and probably *should* have perfect illustrations *and* perfect letter-press accompanying the publication of every new species. Probably, as Mr. OSCAR JOHN points out in a thoughtful note,¹ we should gain something by being more exacting in our requirements, though not primarily along the lines advocated by M. OBERTHÜR, but rather by demanding “that every species to be described should be thoroughly examined from every point of view” ; and if the proposal before us had been to regard no name as valid unless accompanied by a description of the venation, antennal and leg structure, or other details which might be scheduled, I for one should have been loth to raise any opposition to it.

The strong inference, however, is that dependence upon figures would lessen, not increase, the care bestowed in other and more important directions, and would encourage slipshod work ; and actual experience shows that such an inference is justified. In his delightful book *Butterfly-Hunting in Many Lands* (p. 7) Dr. LONGSTAFF tells us that many and many a time he has thanked his stars that he was brought up on STAINTON² “rather than on the spoon-food of NEWMAN,”³ and learned to name his captures from descriptions instead of from figures, and

¹ *Ent. Record*, xxiii., 318-19.

² *Manual of British Butterflies and Moths*.

³ *An Illustrated Natural History of British Butterflies ; An Illustrated Natural History of British Moths*.

it is reasonable to suppose that what is good for the reader is also good for the describer. I have myself experienced—and perhaps in part yielded to—the temptation, when writing to a figured type, to trust to the figure to make the species intelligible, and therefore to “scamp” the descriptive work. Again, when one compares the writings (where such exist at all) of the iconographer HÜBNER with the unillustrated works of BORKHAUSEN, HAWORTH, or TREITSCHKE, can one hesitate a moment in deciding which have done the more to advance the science of entomology? Far be it from me to depreciate the labours of HÜBNER, or to pronounce his generally excellent figures valueless; but one cannot help feeling that his classificatory labours were in large measure stultified by his one-sided attention to wing-pattern (the usual danger of an undue love for the “good figure”), and I confess that when first I realised that the Geometrid portion of HÜBNER’s *Verzeichniss* was contemporary with a part of CURTIS’s work dealing with the same family in a vastly different spirit, I felt—to put it mildly—inclined to challenge the occasionally expressed opinion that HÜBNER as an entomologist was “in advance of his age.” Not that CURTIS despises illustrations, by any means; but he gives anatomical detail, and so raises his work at once to a very different plane.

Before dismissing HÜBNER and his work, I may mention a curious and instructive example of the comparative inefficacy of even a good figure, and the ease with which a few words of description *without figure* could have saved a name from a century of neglect. In his *Sammlung Europäischer Schmetterlinge*, Geometræ tab. 75, fig. 386, he introduces a new species (nom. cum fig.) *Geometra amniculata*, which in my opinion is clearly a rare aberration of *unangulata* Haw., and may likely prove to antedate it.¹ The determination has been tentatively proposed by two or three entomologists, but no one has felt any confidence in it, and it is

¹ As scraps of information concerning the dates of HÜBNER’s works are always useful, I would point out one reference which—though it has long been known to me—I unfortunately overlooked in working recently at a joint paper on the subject (SHERBORN and PROUT, *Ann. Mag. Nat. Hist.* (8), ix., 175–180), and which gives a rather earlier date to a few Geometrid plates. *Geometra torvaria* Hüb., which is figured on pl. 71, is mentioned in a review of Esper published February 11th, 1808, in the *Jena. Allg. Lit. Zeit.* (1808, I., No. 35, *vide p.* 279).

only because I happen to possess a very similar aberration, and to have made a very close study of the group, that I have ventured to decide definitely; even in the latest edition of STAUDINGER'S *Catalog* the name is only cited with a query. If, however, venation had been known, or appreciated, by HÜBNER, a very few words would have sufficed to establish his *amniculata* with certainty; for it is *closely like alternata* Müll. (*sociata* Bkh.), but with the areole double instead of single, and no other European species answers to this description.

In this connection it is excusable, and indeed even necessary, that we should examine M. OBERTHÜR'S own treatment of the relative claims of good descriptions and good figures, particularly in fasc. v., pt. 2, of his *Études de Lépidoptérologie Comparée*, where he has shown us that he has the courage of his convictions, by ignoring many descriptions which even the veriest tyro would pronounce adequate for determination¹ and figuring numbers of well-known species under new names. Now a very slight examination of the letterpress will show that quite a number of these names are nothing more than "nom. cum fig."² and therefore would have no nomenclatural standing in the opinion of the author of the *Index Animalium*, of my late friend Mr. G. W. KIRKALDY the hemipterist, and of many other zoologists. I am not prepared myself to take that extreme position, as the works of HÜBNER and of FELDER, etc., have been so unanimously accepted by lepidopterists, and am willing to submit to them as the penalty for that superficiality of which I spoke in opening; but the fact that such *nomina indeskripta* are here proves to the hilt my contention that even the most zealous of lepidopterists is in danger of lapses so soon as he begins to think that the recognition of species depends upon figures.

The loss to science is very great. Unless the monographer possesses the species, or has access to the type, he is powerless to place it, and it has to remain outside the pale of systematic entomology until it is acquired. Even the best illustration,

¹ E.g., to cite one only, *Brotis studiosa* Dogn., *Le Nat.*, 1891, p. 278 = *Hygrochroa* (?) *leonidaria* Ob., *Ét. Lép. Comp.*, v. (2), 47, t. 92, f. 898.

² Such is the case, *inter alia*, with seven in succession on page 43—*gortyniaria*, *gorgyraria*, *gorgonearia*, *gorgosaria*, *gonnapearia*, *petropolisaria*, and *schunkei*.

except in the case of certain genera of very unmistakable facies, does not allow of safe guessing. Every systematic lepidopterist, whatever his particular views of mimicry, convergence, colour-groups, or other bionomic questions, has learned the truth of the poet's line that "things are not what they seem," and unless the author describes the structure, or gives us some assurance that he has examined it, and that it agrees with the assigned structural characters of such-and-such a genus, it is hopeless to do anything with the species. I do not wish to be hypercritical, but it would seem that in the case of such a species as *Micronissa doddaria* Ob. (*Ét. Lép. Comp.* v. (2), t. 93, f. 910), even the family could hardly be fixed without more enlightenment; the close superficial resemblance between certain Geometrids, certain Epiplemid (Uraniids), and even certain Drepanids is well known, and no hint is given, either by word or by figure, of the structure of our *Micronissa*. So, too, as M. DOGNIN has already pointed out¹ in his valuable synonymic notes, *Uraapteryx chanchamayoria* Ob. and *U. balzapambaria* are actually well-known Uraniids; but how were we to learn the affinities from the published information? M. OBERTHÜR's beautiful figures of *Microgonia* (*Oxydia* Guen.)² I accept with sincere thanks as a real and definite help, especially where there is anything to be gained from a knowledge of the exact shape, or when one wishes to fix a standard for the use of a name (specific or aberrational) in the case of some variable species with which one is already acquainted; but even these do not always afford the assistance which would have been given by a simple description of MEYRICK'S—if it be not invidious to mention one name where so many might well have served my purpose. For I have at least one variable species of *Microgonia* in my collection, which I have separated chiefly by the very strongly swollen hindtibia of the male, and M. CULOT's species, with a solitary exception (*Sabulodes exhonorata* Guen., t. 89, f. 868) do not possess legs.

On the same grounds, the loss of a type, though always deplorable, would be less disastrous in the case of a well-described but not figured species than in the case of a well-figured but not described one. In both cases equally, to be sure, the only chance for

¹ *Ann. Soc. Ent. Belg.*, lvi., 137.

² *Ét. Lép. Comp.*, 5 (2), t. 93-95.

progress in the knowledge of that species would lie in the discovery of other specimens of it, and for this purpose all that I have said above regarding identification is applicable. The rediscovery would carry greater assurance if there were given structural characters on which the determination could be confirmed. But failing (or pending) that rediscovery the species would still have a definite existence in the mind and in the work of the systematist. M. OBERTHÜR¹ makes a great point of this question of lost types, and in particular of a list by HAMPSON of "species described by WALKER and NIETNER from Ceylon, of which the descriptions are insufficient for identification, and the types lost." There is really nothing in this quotation to influence the question. If MÖSCHLER, in working out the fauna of Surinam, had appended a "List of species figured by CRAMER of which the figures are insufficient for identification, and the types lost," would my friend say that this in the slightest degree invalidated his advocacy of good figures? Moreover, the words "insufficient for identification" must always be measured by personal factors, and especially by the nature of the material at hand for comparison. A figure of CRAMER'S or a description of WALKER'S which has been pronounced unidentifiable has often become perfectly intelligible directly the like specimens have been acquired or compared with it. As a matter of fact, since HAMPSON wrote, this has actually happened with some of the "lost species" of WALKER. The late Mr. VERRALL, it will be remembered, expressed a strong *desire*² that *all* types might be "lost" in order that descriptive Entomology might improve. Similarly, he might very probably, had he been a lepidopterist, have desired the prohibition of all figures! I am not going to follow him either in the real or the supposed view, but I mention it as showing another and very idealistic—though in my opinion impracticable—standpoint.

The unidentified species, to whatever causes due, are always the crux of the monographer, but his zeal for "seeing the type" is not attributable, as one or two writers have suggested, to the inadequacy of descriptions for purposes of determination, but rather to advances in research, which necessitate the considera-

¹ *Ét. Lép. Comp.*, 5 (1), pp. xxxiii, xxxiv.

² *Proc. Ent. Soc. Lond.*, 1900, p. xlvii.

tion of previously neglected characters. There is therefore a great difference between the figure which leaves virtually *all* the characters as subjects for inquiry, and the description, which furnishes these in varying degrees, according to its completeness. For myself, I do not think I would give a sixpence for the chance of examining most of Dr. A. J. TURNER'S Australian types, for his descriptions give me all that I at present require. But I should scarcely think a journey to Australia too great a price, if by that means and no other I were able to study the mysterious (though all figured) species of *Leptographa* Hüb. and *Hyphalia* Hüb. which have stood in the way of my recent revision of the *Hemitheicæ*.¹

It is further to be observed that misidentifications themselves can be of various degrees as regards the resultant mischief, and that here once more the advantage is with the description, not with the figure. If I mistake my species for another which, by correct description of structural characters, I find agrees with it, and so record it from an erroneous locality, I have done mischief, assuredly ; but not to nearly the same extent as if (being robbed of my structural clues) I mistake a South American Uraniid (sens. lat.) for an old-world Drepanid or Ourapterygid. In the former case I probably do no serious violence to geographical zoology, for my species, whatever it really is, evidently shows the presence of the structure-group in the country from which I record it ; whereas in the latter event I ascribe to the Neotropical fauna families or subfamilies that may never have reached it. The same reasoning manifestly applies to any other kind of deductions which might result from my false data ; if I describe the larva of a *Cyllopoda* which is really a *Cyllopoda* I have advanced scientific knowledge, though I may actually have a twin species to the one which I suppose ; but if my supposed *Cyllopoda* is really a Dioptid, it is a very far more serious matter.

I have only to mention one other objection to the proposed law that without a good figure *no name* is valid, but it is one that may appeal to practical lepidopterists who trouble little about questions of structure or of classification. It is this : that it imposes an almost impossible burden for absolutely no adequate

¹ *Gen. Ins.*, fasc. 129.

return. Most practical workers are agreed that every differentiable geographical race needs a name, and many also hold that clearly defined and recurrent aberrations (particularly those which suggest Mendelian segregation) should bear names likewise. What conceivable purpose can be served by demanding a new figure when there is a slight but definite difference which can be most clearly indicated in words? Supposing that the local race of a well-known butterfly from a certain island is distinguished by having "the spots of the outer row united into a band," must we figure the species anew to prove our very plain and unmistakable words? What an insult to intelligence!

Or take a polychromatic species like *Minoa murinata* Scop. Shall we have one figure and one name, and be forbidden to name the other colour-forms which we describe, unless we are prepared to figure them? Or must we figure all the colour-forms in any case (whether we name them or not) before we can claim to have adequately made known the species? This species is in more than one respect an ideal one to illustrate my argument. Is a white figure of a black moth going to help us much without letterpress? On the other hand, *Minoa murinata* has no congener in the Palaearctic Region, nor, so far as I know, in the whole world. A simple generic diagnosis and a few words of description of the coloration of the species (it has no markings) would give absolute certainty of determination. And if I discovered a snow-white race of it which demanded naming, I protest that the best figure conceivable could not serve me better than a few strokes of the pen—" *Minoa murinata nivea*, subsp. nov. All the wings snow-white." A friend who is interested in botany as well as in the Lepidoptera tells me that botanists would think it absurd to be expected to illustrate every slight variation which was distinguished by a name, and it is hard to see why language should not be as effective in the hands of lepidopterists as in the hands of botanists.

In conclusion I would sum up very briefly the points which I desire especially to emphasise. Figures are good and useful, and their employment should be encouraged, if they can be regarded as a part only, and a subordinate part, of descriptive work; and the figures should be of just that part or those parts—whether palpus, leg, antenna, or whatever else—which best differentiate

the species from its nearest known ally. But figures are never *necessary*; it is language which must convey conceptions. And experience has shown that figures—more especially what I have called “pictures”—encourage neglect of the true medium of language. Pictures leave us in the dark regarding structure, leave the species unarrangeable systematically, and in cases of misidentification by their means may lead to misidentification of the most disastrous kind. The figuring of every named form, moreover, is absolutely superfluous, and therefore a wasteful expense, because (particularly in the case of subspecies and aberrations) a slight deviation from “type” is much more easily and simply brought out by verbal diagnosis. No new rule is therefore necessary, unless it be one which shall tend to limit faulty descriptions or lack of description by demanding certain information as to structure, and unless at the same time it be acceptable to zoologists as a whole.

I have not rehearsed certain arguments on the grounds of *convenience*, which have already appeared in *The Entomologist's Record*, such as that of MR. BETHUNE-BAKER,¹ that *historical* study (or the *past* of Entomology) would be thrown into chaos, or my own,² that the floodgates would be opened for a series of similar upheavals (endangering the *future* of Entomology) as standards of “goodness” in iconography advanced; but I trust I have already said enough to show that to me, at any rate, the acceptance by scientific lepidopterists of such a law as is proposed is absolutely unthinkable.

¹ *Ent. Record*, xxiii., 271.

² *Tom. cit.*, p. 264.

ALGUNOS ÓRGANOS DE LAS ALAS DE LOS INSECTOS.

Por el R. P. LONGINOS NAVÁS, S.J., ZARAGOZA.

(Text-figs. 1-4.)

EN el Congreso de Entomología de Bruselas tuve el honor de presentar algunas observaciones sobre determinados órganos de las alas de los Insectos, si bien concretando mi atención á las de los Neurópteros.

Posteriormente en el Congreso de Granada celebrado por la Asociación Española para el Progreso de las Ciencias amplié algunas de aquellas observaciones y presenté otras nuevas.¹

Habiendo tenido ocasión, en mis tareas constantes taxonómicas, de hacer otras ampliaciones y descubrimientos y notado que mis observaciones en el Congreso de Bruselas presentadas habían servido de estímulo á otros para más fructíferas investigaciones, me he decidido á reunir en esta breve nota el fruto de mis observaciones posteriores al Congreso de Bruselas, como continuación y complemento de aquéllas.

Seguiré en la exposición el orden en mi primera nota establecido.

1. Pupila (fig. 1).

Este órgano característico lo cité primeramente como propio de las familias de los Diláridos, Osmílidos y Neurómidos (*Memorias del Congreso de Bruselas*, pp. 70-73).

Al describir algunas especies del género *Campodotecnium* Enderl. (*Revue Russe d'Entom.*, 1911, p. 115) apunté la sospecha de

¹ Mi trabajo fué presentado en el Congreso de Granada celebrado en Mayo de 1911, aunque se imprimió entre las memorias del Congreso de Valencia tenido en 1910.

que todas las especies de este género estaban dotadas de *pupilas* y consigné por primera vez la presencia de este órgano alar en la familia de los Panórpidos.

Llevado de este primer indicio, he podido reconocerlo asimismo en otros géneros y especies de esta misma familia existentes en mi colección, tales como *Panorpa* L., *Panorpodes* McLachl., *Aulops* Enderl., *Etenalla* Nav., *Bittacus* Latr., *Harpobittacus* Gerst., *Haplodictyus* Nav., *Thyridates* Nav. Esta larga enumeración de géneros me induce á creer que tal órgano existe en todos los géneros y especies alados de Panórpidos.

Semejante estructura de las alas hace más próximo de lo que se creía, á mi ver, el parentesco de los Panórpidos con otras familias de Neurópteros Planipennes citadas anteriormente y dificulta el separarlas, como se ha hecho, en orden autónomo.

Muchas veces es difícil observar la pupila en algunos Panórpidos, ya por ser incolora, ya por hallarse en alguna de las

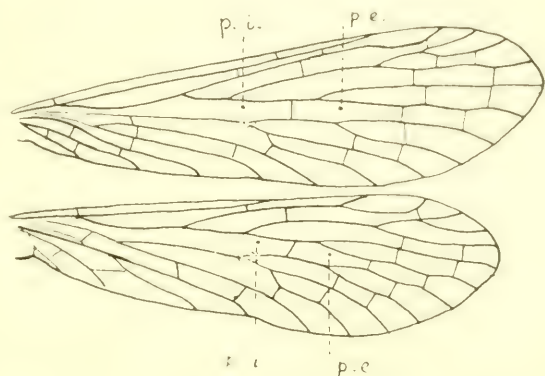


FIG. 1.—*Panorpa germanica* L. ♂. Pupilas de ambas alas. *P. i.*, pupila interna. *P. e.*, pupila externa. (Col. m.)

manchas de las alas, pero siempre me ha sido posible reconocerla, al menos con lente de fuerte aumento.

Su posición es invariable en las especies de Panórpidos que he visto. Hállanse dos pupilas en cada ala y ambas en el campo que llamo intermedio, ó sea entre el sector del radio y el procúbito (vena mediana); la primera ó interna (Fig. 1, *p. i.*) detrás del primer ramo del sector y la segunda ó externa (Fig. 1, *p. e.*) detrás del segundo ramo, en la segunda celdilla intermedia.

Sirvan de tipo los dibujos adjuntos de las alas de la *Panorpa germanica* ♂ L. en que se ha prescindido de las manchas para hacer resaltar bien la posición y forma de las pupilas (fig. 1).

2. Tiridio.

Este órgano tan conocido en los Tricópteros y consignado además por mí en otras dos familias de Neurópteros, los Osmílidos y Panórpidos (*Memorias del Congreso de Entomología de Bruselas*, p. 76) se halla también por lo menos en algunas especies de otras dos familias de Neurópteros.

1. *Crisópidos*. Es bastante sensible el tiridio en dos especies de *Nothochrysa*, la *capitata* F. y la *fulviceps* Steph. (*Feuille des Jeunes Nat.*, 1911, Mars, p. 70, fig.). Siendo el tiridio propio de la vena procubital, en estas especies se halla situado junto á la axila ó división del procúbito, no en el mismo ángulo ó axila, sino junto á él, en el ramo anterior solamente. En otras especies de *Nothochrysa*, como *italica* F., *stigmatica* Ramb., *variegata* Burm., *Finoti* Nav., *Oberthuri* Nav., no he podido distinguirla. Tampoco la he podido hallar en otros géneros de Crisópidos, tales como *Chrysopa* Leach, *Apochrysa* Schn., *Eremochrysa* Banks, etc.

2. *Efeméridos*.—En una sola especie la he observado, la *Ephemer Schoutedeni* Nav. (*Act. Soc. Scient. Bruxelles*, 1911, p. 223, fig. 3), del Congo belga. Su posición es exactamente la misma que en las *Nothochrysa* mencionadas, ó sea en la primera bifurcación de la vena procubital (la 6 de EATON), al principio de la rama anterior, muy cerca de su axila, distinguiéndose por el color más pálido que toma allí la vena, sin limbo ó mancha que la circunde.

Será este carácter suficiente razón para separar en género distinto las dos especies provistas de tiridio é incluídas hasta ahora en el género *Nothochrysa* y la *Ephemer Schoutedeni*, por la misma causa? Me inclino á creerlo, sobre todo teniendo en cuenta otros caracteres que les son peculiares; y si vuestros votos me autorizan, formaré para ellas los géneros *Nathanica* y *Eatonica* respectivamente, cuya característica podrá ser la siguiente.

Nathanica gen. nov.

En obsequio de D. NATÁN BANKS, distinguido investigador de los Crisópidos.

Antennæ fortes, ala anteriore breviores.

Prothorax subquadratus.

Abdomen cercis haud exertis.

Venulæ gradatæ seriei internæ in arcum extrorsum concavum dispositæ.

Procubitus in ala anteriore thyridio distinctus, seu macula pallida interruptus in ramo anteriore juxta axillam. Cubitus haud incrassatus.

Cetera ut in *Nothochrysa* McLachl.

Tipo de este género será la *N. capitata* F. y en el mismo se incluirá la *N. fulviceps* Steph.

Eatonica gen. nov.

Del nombre de EATON insigne monógrafo de los Efeméridos. Similis *Ephemeræ*.

Pedes anteriores ultimo articulo longo, duobus præcedentibus simul sumptis æquilongo.

Alæ disco haud maculato.

Ala anterior vena procubitali (6 EATON) bis furcata, thyridio manifesto ad primum ramum anteriorem, juxta primam axillam; vena postcubitali (8 EATON) longa, initio flexuosa, apice ad marginem externum, ultra angulum posticum desinente, pluribus ramis distincta; venis axillaribus (9¹ et 9² EATON) longis, ultra medium marginis posterioris finientibus; area axillari seu posteriore longa et angusta, venulis brevibus.

Ala posterior ultimis venis fere simplicibus.

Cetera ut in *Ephemeræ*.

El tipo es *E. Schoutedeni* Nav.

Las alas diferencian con facilidad este género de las formas típicas de *Ephemeræ*, sobre todo el campo axilar del ala anterior, que es ancho en la base y corto en el género *Ephemeræ* típico, y por el contrario estrecho y alargado en el nuevo.

3. **Regma** (lat. *rhegma*).

Así llamada (*Memorias del Congreso de Valencia, Ciencias Naturales*, 1911, p. 100, fig. 1) del griego ῥήγμα, hendidura, grieta. Son unas manchitas pálidas que parecen interrumpir algunas venillas bien coloreadas, á manera de corte ó hendidura.

La observé en algunas especies de Mirmelcónidos (Neur.)

del género *Creagris* Ramb. bien coloreados, como *africanus* Ramb., *V-nigrum* Ramb., y *litteratus* Nav.

Su situación es invariablemente (en el género *Creagris*) en el tercio apical del ala, por delante del procúbito (vena mediana), en una manchita, única en el ala posterior y doble en la anterior, cada una con su correspondiente *regma*.

Al definirla admití que podía llamarse asimismo *regma* toda manchita análoga corta, perpendicular á una venilla, aunque se encuentre en sitio distinto del ala.

Ahora puedo añadir que semejante particularidad la he observado en otras muchas especies de diferentes géneros y aun familias de Neurópteros.

1º. Género *Creagris* Ramb. Es visible en los ejemplares bien coloreados de las especies *plumbeus* Oliv., *latens* Nav., *plagatus* Nav. y hay indicios de la misma en otras como el *nubifer* Kolbe, por cuanto las venas se aproximan en aquella región, que presenta una estructura idéntica y por este motivo denomino *región regmática*. Por lo cual es de creer se halla la *regma* en todas las especies del género *Creagris* y acaso de la tribu de los Creagrinos, por lo que voy á decir.

2º. En la especie típica *Tahulus caligatus* Nav. de mi género *Tahulus* (*Revue Russe d'Entom.*, 1912, p. 112), también Creagrino.

3º. El *Obus arenosus* Nav. tipo de mi género *Obus* (*Broteria*, 1912, p. 58), Creagrino, de organización aberrante por carecer de espolones, posee la *regma* muy notoria en ambas alas.

4º. La mancha regmática es bien visible en el *Formicaleo tetragrammicus* Pall. tipo del género *Formicaleo* Leach y de la tribu de los Formicaleoninos Nav., por más que la *regma* propiamente dicha sólo se distinga con fuerte aumento en esta especie y en otras del mismo género, como *bistrigatus* Ramb., *diversus* Nav., etc.

5º. Es más visible la *regma* en las especies del género *Banyutus* Nav. (*Broteria*, 1912, p. 66), como en el tipo *lethalis* Walk., y más aún en el *horridus* Nav.

6º. En la familia de los Hemeróbidos puede distinguirse la *regma*. Mi especie *Nusalala rhegmatica* debe su nombre á la *regma* que se nota en muchas venillas gradiformes del ala anterior de las series media y externa (fig. 2).

7º. En la familia de los Crisópidos reaparece la *regma* en

otra forma. Las venillas intermedias (entre el sector del radio y el procúbito) del ala anterior de la *Nothochrysa italica* Rossi, vistas con fuerte aumento, parecen palidecer en su terminación en el procúbito, como adornadas de una forma de regma.

Y es de creer que se hallarán semejantes modificaciones en otras especies, géneros y familias de Neurópteros.

Ni debe confundirse esta regma del campo intermedio con la *estriola* (*Congr. de Entom. de*

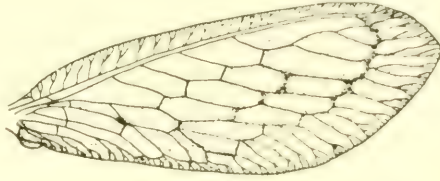


FIG. 2.—*Nusalala rhegmatica* Nav. Ala anterior. (Mus. de Munich.)

Brusclas, p. 74), pues ésta ocupa diferente posición y afecta á la vez á la membrana, en forma de línea alargada ó pliegue.

4. **Ampolla** (lat. *bull*a).

Este órgano consiste en una hinchazón situada en el margen posterior del ala. Lo he llamado *ampolla* (en latín *bull*a) por su figura y disposición (*Congreso de Valencia, Cienc. Nat.*, p. 101, fig. 2).

Ya lo mencionó Walker en su *Osmylus tuberculatus* (*Brit. Mus. Neur.*, 1853, p. 235, n. 7), llamándolo *tubérculo*, "a brown tubercle with yellow stripes."

Kolbe al establecer el subgénero *Spilosmylus* (*Die Netzflügler Deutsch-Ost-Afrikas*, Berlin, 1897, p. 34) lo llamó en latín *pustula* en su característica. Mas como no pretendió inventar nuevo nombre para designar este órgano y el de *ampolla* (*bull*a ó *vesicula* en latín) es más general y adecuado para las diferentes formas que presenta, lo he preferido para designarlo con su nombre propio.

Es característico del ♂ en determinados géneros y familias de Neurópteros.

1°. En el género *Spilosmylus* Kolbe (Osmílidos) se nota en el ♂ hacia el tercio del ala posterior del ala primera (fig. 3, a).

No veo medio de distinguir las ♀ que á este género pertenecen, pues la manchita que presentan casi en igual sitio del ala anterior (fig. 3) pueden ofrecerla otros géneros de

Osmílicos. Las líneas intercaladas en el campo subcostal pueden ser acaso mejor indicio, pues sólo las he visto en especies del género *Spilosmylus*. El dibujo que presento es del ala anterior de un ejemplar ♀ que refiero al *Spilosmylus interlineatus* McLachl., del Museo de Londres, y lleva por rótulo: S. E. Katanga, 30-II-07, 4,000 ft., Neave coll. Su presencia en

Katanga confirma el origen africano que atribuyó MAC-LACHLAN á esta especie.

2º. El género *Nina* Nav. (Nemop-téridos). En éste la ampolla existe en ambas alas. En la anterior su posición y figura es parecida á la del género *Spilosmylus* Kolbe, sino que parece vellosa ó más bien velutina y no lampiña, sin rayas, de diferente color en el margen, formando escotadura. En el ala

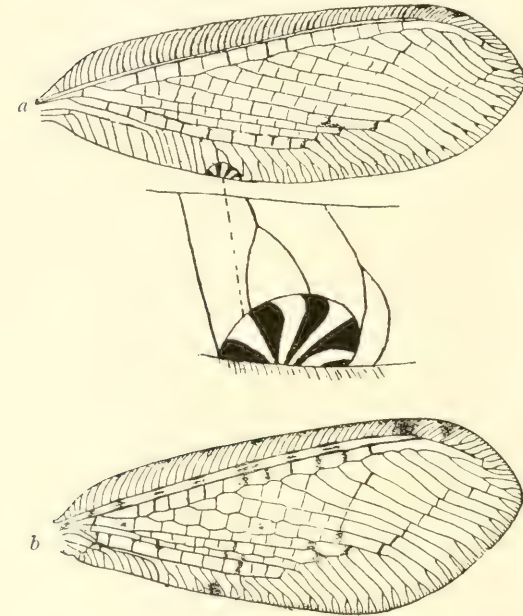


FIG. 3.—(a) *Spilosmylus tuberculatus* Walk. ♂. Ala anterior y ampolla. (b) *Spilosmylus interlineatus* ♀, McLachl. (Mus. de Londres.)

el tercio basilar y es alargada, piriforme en forma de lágrima, afelpada, blanquecina, situada en el margen posterior, que por la forma y posición alargada de las alas resulta interno.

5. Botón (lat. *philula*).

El primero que mencionó este órgano fué RAMBUR al hablar del género *Palpares* (*Névroptères*, p. 366) en estos términos: "Ailes inférieures chez les mâles, ayant à leur articulation, postérieurement, une petite dilatation, munie à son extrémité d'une petite pelote."

WALKER (*Cat. Neur. Brit. Mus.*, 1853, p. 329) lo llama *alula*, cuando dice: “*Maris alæ posticæ alula parva apud basim posterioris munitæ.*”

MACLACHLAN lo conoció no sólo en el género *Palpares*, sino también en otros de Mirmeleónidos, llamándolo también “pelote” aunque escribía en inglés.

Conformándome con el uso de estos Neuropterólogos, aunque generalizando más y con nombre más apropiado á su forma lo he llamado *botón*, en latín *pilula* (*Congreso de Valencia*, p. 103, fig. 3). Efectivamente tiene la forma exacta de botón, con su soporte ó peciolo y su correspondiente disco.

Su presencia es de grande utilidad taxonómica, por ser exclusivo del sexo masculino, en algunos géneros de Mirmeleónidos, cuyo aparato genital externo es poco perceptible.

Entre los que lo poseen, según mis observaciones, son los siguientes.

Tribu Palparinos. Todos sus géneros.

Tribu Acantaclisininos. Todos sus géneros.

Tribu Mirmeleoninos. Géneros: *Myrmelcon* L., *Macroleon* Banks, *Hagenomyia* Banks, *Baliga* Nav., *Balaga* Nav., *Enza* Nav., *Gepus* Nav.

Tribu Neuroleínos. Géneros *Neurolcon* Nav., *Nelces* Nav.

Tribus Formicaleoninos, Creagrinos y Gimnocneminos. En mi colección no hallo ninguno que lo posea.

6. Nudillo (lat. *nodulus*).

Así puede llamarse el engrosamiento que sufre alguna vena, especialmente en el sitio en que concurren venillas ó ramos, simulando un nudo.

Lo señalé por primera vez (*Congreso de Valencia*, p. 104, fig. 3) en los Acantaclisininos, tribu de la familia de los Mirmeleónidos. En casi todos sus géneros y especies es muy visible un engrosamiento del postcúbito del ala posterior, en el cual concurren algunas venillas por uno y otro lado, cual si formasen nudo alargado.

Es además muy conocido el engrosamiento que sufre el cúbito del ala anterior en muchos Crisópidos, precisamente en el sitio en que concurren la primera venilla procubital por

delante y la primera cubital por detrás. Este ensanchamiento puede también apellidarse *nudillo*. El género *Nathanica* que acabo de formar carece de este órgano, ó apenas es sensible.

Finalmente he hallado un órgano semejante en la ♀ del

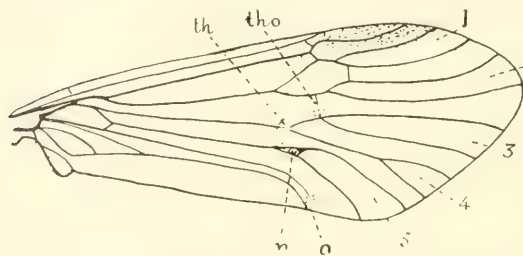


FIG. 4.—*Glossosoma Boltoni* McLachl ♀. Ala anterior: *n*, nudillo; *o*, ostiola; *th*, tiridio; *tho*, tiridiola; 1, 2, 3, 4, 5, horquillas apicales. (Col. Codina.)

Glossosoma Boltoni McLachl. (Tricóptero), el cual puede asimismo apellidarse nudillo, á no ser que se prefiera designarlo con el nombre de *callo* (*callus* en latín) más general y que podrá apli-

carse en muchos casos, aun fuera de la reticulación de las alas. Pero es preferible el nombre de nudillo, por la analogía que presenta con los ya descritos en otros grupos.

En la especie antedicha hállase en la ala anterior, en la axila de la horquilla 5 apical, ó en el extremo de la rama posterior del procúbito, que se engruesa antes de dividirse ó ahorquillarse (fig. 4, *n*).

En el ♂ de la misma especie existe un callo característico en la base del ala anterior; la ♀, que carece de dicho callo; posee esotro órgano que he llamado nudillo.

En la figura que acompaño se pueden ver además otros órganos de las alas que en otros trabajos anteriores he mencionado.

LES VARIÉTÉS DOIVENT-ELLES ÊTRE NOMMÉES?

Par CH. KERREMANS, BRUXELLES.

LA question a son importance et mérite d'être examinée.

Il sera toujours difficile de réglementer ou de refréner ce que l'on pourrait appeler la manie descriptive ; mais on pourrait diminuer le nombre des descriptions en décidant de ne les admettre que pour autant qu'elles soient insérées dans l'étude systématique d'un groupe ou dans celle d'un ensemble faunique, afin de rejeter une fois pour toutes les descriptions isolées, le plus souvent effectuées à la hâte et beaucoup plus dans un intérêt purement spéculatif, pour satisfaire une mesquine question d'amour-propre ou pour posséder beaucoup de types, et dans laquelle l'intérêt scientifique n'intervient que d'une façon tout à fait secondaire.

Tel auteur reconnaît une espèce dans laquelle un autre ne considère qu'une variété et l'accord ne s'établira qu'avec beaucoup de peine, parce que la définition intégrale de l'espèce n'est pas connue et ne le sera probablement jamais.

Il est indispensable de donner un nom à un ensemble de formes paraissant dériver d'un même type ; il est tout aussi indispensable d'en donner un au groupement réunissant des formes ayant, outre le facies, des caractères communs, celui-ci constituant le *genre*, l'autre l'*espèce*.

Mais dans un ensemble d'individus appartenant à la même espèce, on n'en trouvera pas deux absolument identiques ; ils varient indéfiniment, tantôt par des détails à peine perceptibles, tantôt d'une manière considérable. Est-il nécessaire, est-il seulement utile d'imposer un nom à ces variations ? Je ne le pense pas.

Il est bien entendu que mon appréciation, toute personnelle, ne vise qu'une seule famille d'insectes que j'étudie depuis plus

de trente ans et que je connais encore très peu. Tout ce que je dirai ne se rapporte donc qu'aux Buprestides, mais d'une façon générale on peut dire que mes remarques s'appliquent à tous les Coléoptères.

Vouloir donner un nom à toutes les différences que peuvent présenter entre eux les individus d'une même espèce, c'est se lancer dans l'infini ; c'est surtout perdre son temps, ce qui serait peu de chose si cela ne le faisait pas perdre aux autres.

Certes, si l'on étudie une espèce au point de vue de la variation, il est du plus haut intérêt de détailler les passages d'un extrême à l'autre. Cette étude peut donner matière à des résolutions relatives à la philogénie, à la distribution géographique, à l'établissement de races, à toute une série de questions passionnantes. Mais, encore une fois, est-il nécessaire, est-il seulement utile de donner un nom à ces passages et à leurs intermédiaires ?

Si l'on tient à les énumérer, une simple lettre ou un numéro d'ordre pourraient suffire ; bien que je ne le juge pas nécessaire.

Et ceci tend à dire que la nomenclature animale est trop nombreuse et qu'il y a lieu de lui faire subir un temps d'arrêt.

Ne fait-on pas œuvre plus utile en établissant sur des bases probantes la synonymie d'une espèce qu'en décrivant une nouvelle forme spécifique ?

Tout récemment, j'ai reçu en hommage un opuscule au cours duquel son auteur décrit quatre nouvelles espèces paléarctiques, chacune d'elles d'après un spécimen unique, et je suis convaincu, sans avoir vu les types, que ces espèces iront rejoindre bientôt des autres très anciennement connues.

Tant qu'un auteur n'a pas vu le type d'une espèce ou, tout au moins, un spécimen comparé au type par un entomologiste compétent, il devrait s'abstenir de décider de sa validité. Car, en se prononçant pour ou contre cette validité rien que d'après la lecture de la description, il risque souvent de se tromper, comme je l'ai fait moi-même en décidant que le *Sternocera multipunctata* Saund. devenait synonyme de l'antique *sternicornis* de LINNÉ, alors que l'examen d'une longue série d'individus m'a fait reconnaître mon erreur, et décider que SAUNDERS avait eu raison de créer cette espèce.

Mais l'accès des types est souvent difficile ; celui des uniques est surtout impossible à ceux qui ne peuvent voyager.

Reprenons la question et examinons quelques groupes de Buprestides à formes variables; ils nous convaincront de l'inutilité du baptême des variétés.

Si nous examinons une longue série de *Sternocera chrysis* Fab., nous en trouverons de toutes les couleurs, depuis le jaune fauve clair jusqu'au noir intense sur les élytres, en passant par le vert, le bleu, le cuivre, le pourpre sur la tête, le pronotum, et le dessous. Ici, il n'y a pas eu abus; on a seulement créé une espèce pour les spécimens noirs: *Chrysidoides* Castelnau et Gory. Ce nom était inutile.

Je possède en collection un assez grand nombre de spécimens du beau *Sternocera pulchra*, si bien nommé par notre collègue M. CHAS. WATERHOUSE. Parmi ces spécimens, je constate onze ou douze variétés bien caractérisées, qui feraient la joie de certains entomologistes, mais auxquelles je me garderais bien de donner un nom. Si j'étudie un jour cette espèce au point de vue de sa variation, j'en décrirai toutes les formes que j'aurai sous les yeux et les comparerai l'une à l'autre, mais je me contenterai de constater les variations, de façon à ne pas embarrasser mes successeurs d'un fouillis de noms qui ne leur diront pas plus à l'esprit qu'une simple lettre distinctive.

Pour certains *Julodis*, des noms peuvent, à la rigueur, être maintenus puisqu'ils existent, tels que *Frey-Gessneri* Meyer, variété du *variolaris* Pallas et les nombreuses races locales du *J. onopordi* Fab. nommées *armeniaca* Mars., *pilosa* Fab., *algirica* Cast., *Kænigi* Mann., *Ehrenbergi* Cast., et *sulcata* Redt.; mais tous les autres noms donnés à cette espèce n'ont guère de valeur et encombrant inutilement la nomenclature.

Si des *Julodis* nous passons aux *Acmæodera* et de là aux *Ptosima*, nous remarquerons que le dessin et les taches claires des élytres et du pronotum, du front et du dessous ont fourni matière à des baptêmes nombreux d'une validité plus que douteuse.

Il est à remarquer du reste que la profusion de noms donnés à une même espèce a lieu, dans la plupart des cas, pour les formes européennes et que les exotiques ont heureusement échappé à cet abus. Et cela s'explique aisément puisque les insectes de provenance européenne sont incomparablement plus faciles à se procurer et parce que les amateurs en sont plus nombreux,

qu'ils soient collectionneurs ou travailleurs. Les premiers font de la collection un but ; les seconds en font un moyen, mais il est si agréable, pour les uns comme pour les autres, de s'imaginer qu'ils possèdent ce que d'autres n'ont pas. Il en résulte une sorte de déformation dans le jugement assez semblable à certaines tares professionnelles, une tendance à imaginer de nouvelles espèces, à créer de nouvelles variétés, à baptiser enfin ces formes qui, la plupart du temps, ne sont qu'accidentelles. Et la nomenclature, déjà si longue et si embrouillée, vient se compliquer tous les jours d'une profusion de noms qu'il eût été si simple de ne pas donner.

Les exotiques ont jusqu'ici échappé à ce fléau, que l'on pourrait appeler le prurit de la description ; je puis donc, en passant en revue les *Buprestides*, passer sous silence les *Chrysochroites* et les *Psiloptérites*, chez lesquels la synonymie est peu compliquée, parce qu'il n'y a guère que des spécialistes tels que HENRI DEYROLLE, EDW. SAUNDERS, et CHAS. WATERHOUSE, qui s'en soient occupés. J'omets à dessein JAMES THOMSON, parce que je ne puis le considérer comme un spécialiste et que je le tiens plutôt pour un fantaisiste de large envergure, décrivant à tort et à travers, sans examen bibliographique, sans comparaison avec les types, et s'amusant à décrire comme nouvelles des espèces de LINNÉ et de FABRICIUS, sous le nom donné par ces anciens auteurs. N'insistons pas.

Passons aux *Buprestides vrais*. Ce qui a été constaté pour les autres groupes continue à se manifester dans celui-ci ; les espèces paléarctiques sont gratifiées d'une quantité exagérée de noms, tandis que les exotiques possèdent une nomenclature normale.

Que les lépidoptéristes, sous le nom d'aberrations, de races, de variétés ou de sous-espèces, mentionnent les moindres particularités du dessin alaire, cela s'explique, puisque le critérium des caractères spécifiques est ce dessin lui-même.

Mais que des coléoptéristes s'ingénient à compter les taches jaunes sur le fond obscur, ou les taches noires sur le fond clair des élytres, du pronotum, ou de l'abdomen alors qu'il y a tant de caractères constants de sculpture et de forme pour délimiter les espèces, qu'ils imposent un nom à ces variations de couleur, c'est tomber dans l'excès. Je citerai à ce propos le curieux

Buprestis sanguinea Fab., d'après lequel j'ai établi le genre *Yamina*. On sait que cette espèce possède un dimorphisme sexuel très accentué : la femelle est d'un beau rouge vif avec des taches bleu foncé (*sanguinea* Fab.), tandis que le mâle est bleu foncé avec un dessin jaune, plus ou moins accentué (*Levailanti* Luc). C'est notre collègue M. CHAMPION qui le premier a reconnu ce dimorphisme. Le dessin jaune du mâle et le bleu foncé des femelles varient extrêmement, parfois il manque sur le pronotum et même sur les élytres. Et sur le nombre de ces taches, un auteur a trouvé le moyen de créer des variétés, telles que *notatithorax*, etc. Je le déplore, comme je déplorerais de voir donner un nom pour chaque variation de dessin du *Stigmodera variabilis* Don. Cette espèce, de l'Australie, est excessivement variable ; j'en ai vu des milliers d'exemplaires, je n'en ai jamais vu deux semblables. Imagine-t-on un bénédictin de l'entomologie s'amusant à prendre, une à une, pour les décrire, toutes les variations du dessin élytral des spécimens de cette espèce ? Or, le *Yamina sanguinea* Fab. est tout aussi variable que le *Stigmodera variabilis* Bon. ; seulement, il est plus rare, on en connaît donc moins d'exemplaires, et il est aussi inutile de donner des noms de variétés à celui-ci qu'à l'autre, car en le faisant, on tombe dans l'absurde.

Je me résume et je finis comme j'ai commencé en disant qu'il est temps d'enrayer la manie descriptive des espèces ; il est temps surtout d'enrayer la manie de donner des noms aux variétés.

Qu'allons-nous faire pour éviter ces abus qui deviendront sous peu un fléau pour les bibliographes ? C'est au Congrès à résoudre la question ; c'est à lui qu'incombe la tâche de chercher le remède.

DIE FORTSCHRITTE DES NEUEN COLEOPTERORUM- CATALOGUS VON JUNK-SCHENKLING.

Von Dr. WALTHER HORN, BERLIN-DAHLEM.

Zu denjenigen entomologischen Aufgaben, welche fast ausnahmslos über die Arbeitskraft des einzelnen hinausgehen, gehören vor allem die Katalogisierungen der Literatur der grössten Insekten-Ordnungen. Seit vielen Jahren war es nun mein stiller Wunsch gewesen, einen derartigen umfassenden Katalog der grössten rezenten Tier-Gruppe, der Coleopteren, zu organisieren; aber leider fand sich lange Zeit hindurch kein Weg zur Verwirklichung dieses Planes. Erst im Jahre 1910 glückte es, einen Verleger für dieses Riesen-Unternehmen zu gewinnen: Es war dies der Berliner Buchhändler W. JUNK, der nicht nur kapitalskräftig genug war, um sich an die Drucklegung eines solchen Werkes heranzuwagen, sondern der auch zu dem von mir vertretenen "Deutschen Entomologischen Museum" (damals noch "Deutsches Entomologisches National-Museum" genannt) das genügende Zutrauen betreffs der wissenschaftlichen Durchführung des Unternehmens besass. Auf meine Bitte übernahm der Custos unseres Museums, Herr S. SCHENKLING, die General-Redaktion. So ist dieser Coleopterorum-Catalogus¹ als echtes Kind unseres "Deutschen Entomologischen Museums" geboren worden. Vor 2 Jahren konnte Herr S. SCHENKLING auf dem I. Internationalen Kongress in Brüssel über die ersten Erfolge seines Werkes berichten.

¹ Seit kurzem erscheint in demselben W. JUNK'SCHEN Verlage ein genau entsprechend organisierter Lepidopterorum-Catalogus, dessen General-Redakteur der Assistent unseres Deutschen Entomologischen Museums, Herr H. WAGNER, ist. Acht Teile sind von demselben bereits erschienen.

Jetzt freut es mich, dem II. Internationalen Entomologen-Kongress von seinem über alles Erwarten glücklichen Gedeihen einen neuen Beweis geben zu können.

Zur Orientierung über den Catalogus sei nur hervorgehoben, dass derselbe in der Art des GEMMINGER-HAROLD'SCHEN Werkes die Haupt-Literatur, die Synonyma, Varietäten und Vaterlands-Angaben sämtlicher bekannter Coleopteren-Species der ganzen Erde enthält. Er erscheint in Lieferungen, eine jede eine abgeschlossene Familie oder Gruppe umfassend, welche in zwangloser Folge, fortlaufend numeriert, herausgegeben werden. Nachdem alle Familien erschienen sind, wird eine Anweisung darüber gegeben werden, wie die Familien nach dem System zu ordnen sind, und es werden Titelblätter für die einzelnen Bände gedruckt werden. Die Literatur über Biologie und Entwicklungsgeschichte der Käfer, namentlich aller Schädlinge, wird besonders sorgfältig registriert. Eine jede Lieferung ist auch einzeln käuflich. Der Preis für den Druckbogen beträgt M. 1.50. Subscribenten auf das ganze Werk erhalten eine Ermässigung von einem Drittel, zahlen also für den Bogen 1 Mark.

Im Jahre 1910 ist der erste Teil des Kataloges erschienen; seitdem sind nicht weniger als 44 Lieferungen von 29 verschiedenen Specialisten mit zusammen c. 4,000 Gross-Oktavseiten herausgekommen. Der Gesamtpreis für diese 44 Lieferungen beträgt für Subskribenten 247.80 M., für Nicht-Subskribenten 371.50 M. Im folgenden gebe ich eine Aufzählung dieser 44 Teile, welche zusammen 68 Coleopteren-Gruppen mit über 43,000 Species umfassen.

Pars 1: R. GESTRO, Rhysodidæ.

2: F. BORCHMANN, Nilionidæ, Othniidæ, Ægialitidæ, Petriidæ, Lagriidæ.

3: —, Alleculidæ.

4: M. HAGEDORN, Ipidæ.

5: R. GESTRO, Cupedidæ et Paussidæ.

6: H. WAGNER, Curculionidæ: Apioninæ.

7: H. von SCHÖNFELDT, Brenthidæ.

8: G. van ROON, Lucanidæ.

9: E. OLIVIER, Lampyridæ.

Pars 10 : —, Rhagophthalmidæ, Drilidæ.

11 : A. LÉVEILLÉ, Temnochilidæ.

12 : E. CSIKI, Endomychidæ.

13 : —, Scaphidiidæ.

14 : M. PIC, Hylophilidæ.

15 : H. GEBIEN, Tenebrionidæ I.

16 : P. PAPE, Brachyceridæ.

17 : PH. ZAITZEV, Dryopidæ, Cyathoceridæ, Georyssidæ, Heteroceridæ.

18 : E. CSIKI, Platypyllidæ, Orthoperidæ, Phænocephalidæ, Discolomidæ, Sphæriidæ.

19 : M. BERNHAUER et K. SCHUBERT, Staphylinidæ I.

20 : A. SCHMIDT, Aphodiinæ.

21 : K. AHLWARTH, Gyrinidæ.

22 : H. GEBIEN, Tenebrionidæ II.

23 : S. SCHENKLING, Cleridæ.

24 : H. BICKHARDT, Histeridæ.

25 : K. W. von DALLA TORRE, Cebrionidæ.

26 : M. PIC, Scaptiidæ, Pedilidæ.

27 : A. RAFFRAY, Pselaphidæ.

28 : H. GEBIEN, Tenebrionidæ III.

29 : M. BERNHAUER et K. SCHUBERT, Staphylinidæ II.

30 : K. W. von DALLA TORRE, Cioidæ.

31 : —, Aglycyderidæ, Proterrhinidæ.

32 : E. CSIKI, Platypyllidæ, Ptiliidæ.

33 : K. W. von DALLA TORRE, Nosodendridæ, Byrrhidæ, Dermestidæ.

34 : P. KUHN, Erotylidæ—C. RITSEMA, Helotidæ.

35 : J. WEISE, Chrysomelidæ, Hispinæ.

36 : M. PIC, Anthicidæ.

37 : H. GEBIEN, Tenebrionidæ IV (Ultima pars), Trictonotomidæ.

38 : J. J. E. GILLET, Scarabæidæ : Coprinæ I.

39 : CHR. AURIVILLIUS, Cerambycidæ : Cerambycinæ.

40 : M. BERNHAUER et K. SCHUBERT, Staphylinidæ III.

41 : M. PIC, Ptinidæ.

42 : A. SCHMIDT, Scarabæidæ : Ægialiinæ, Chironinæ.

43 : G. J. ARROW, Scarabæidæ : Pachypodinæ, Pleocominæ, Aclopinæ, Glaphyrinæ, Ochodæinæ, Orphninæ, Idio-

stominæ, Hybosorinæ, Dynamopinæ, Acanthocerinæ,
Troginæ.

Pars 44: H. STROHMEYER, Platypodidæ.

Im Laufe des Herbstes wird die Drucklegung zweier weiterer grosser Familien (Coprinen und Staphyliniden) beendet sein; alle übrigen Coleopteren sind in Vorbereitung¹ und werden von folgenden Autoren bearbeitet:

G. J. ARROW, Dynastinæ, Passalidæ.

CH. AURIVILLIUS, Lamiinæ.

A. BOUCOMONT, Geotrupinæ, Taurocerastinæ.

H. CLAVAREAU, Chrysomelidæ (excl. Galerucinæ, Hispinæ et Cassidinæ).

E. CSIKI, Mordellidæ, Aphænocephalidæ, Rhipiphoridæ, Carabidæ.

K. W. v. DALLA TORRE, Melolonthinæ, Curculionidæ.

E. FLEUTIAUX, Elateridæ, Eucnemidæ, Throscidæ.

W. W. FOWLER, Languriidæ.

CH. J. GAHAN, Rhipiceridæ, Pythidæ, Pyrochroidæ.

A. GROUVELLE, Nitidulidæ, Cucujidæ, Cryptophagidæ,
Colydiidæ, Byturidæ, Synteliidæ.

W. HORN, Cicindelidæ.

K. JORDAN, Anthribidæ.

CH. KERREMANS, Buprestidæ.

H. J. KOLBE, Cetoniinæ.

A. LAMEERE, Prioninæ.

¹ Seit Tagung des Kongresses sind folgende weitere Lieferungen erschienen:

Pars 45: K. W. von DALLA TORRE, Melolonthinæ I.

46: A. BOUCOMONT, Taurocerastinæ, Geotrupinæ.

47: K. W. von DALLA TORRE, Melolonthinæ II.

48: M. PIC, Anobiidæ.

49: K. W. von DALLA TORRE, Melolonthinæ III.

50: —, Melolonthinæ IV.

51: H. CLAVAREAU, Chrysomelidæ: Sagrinæ, Donaciinæ, Orsodacninæ, Criocerinæ.

52: A. LAMEERE, Cerambycidæ: Prioninæ.

53: H. CLAVAREAU: Chrysomelidæ: Megascelinæ, Megalopodinæ, Clytrinæ, Cryptocephalinæ, Chlamydinæ, Lamprosominæ.

54: E. CSIKI, Rhipiphoridæ.

55: M. PIC, Bruchidæ.

P. LESNE, Bostrychidæ, Lyctidæ.
 A. MEQUIGNON, Rhizophaginæ.
 F. OHAUS, Rutelinæ, Euchirinæ.
 M. PIC, Melyridæ, Anobiidæ, Bruchidæ.
 G. PORTEVIN, Silphidæ, Clambidæ, Leptinidæ.
 S. SCHENKLING, Derodontidæ, Lymexylonidæ.
 G. SEIDLITZ, Oedemeridæ.
 A. SICARD, Coccinellidæ.
 F. SPAETH, Cassidinæ.
 J. WEISE, Galerucinæ, Halticinæ.
 F. BORCHMANN, Meloidæ.
 PH. ZAITZEV, Hydrophilidæ.

Interessant ist ein Vergleich einiger sich in diesem neuen Catalog ergebenden Species-Zahlen mit denen des GEMMINGER & HAROLD'SCHEN Cataloges. Ich gebe in folgendem einige Beispiele dazu:

	Schenkling, 1910-12.		G. & H., 1868-76.		Schenkling, 1910-12.		G. & H., 1868-76.
Rhysodidæ	109	.	11	Scaphidiidæ	245	.	51
Othniidæ	16	.	3	Hylophilicæ	336	.	107
Lagriidæ	551	.	131	Dryopidæ	453	.	111
Ipidæ	1,234	.	534	Gyrinidæ	423	.	147
Paussidæ	298	.	99	Cleridæ	2,285	.	697
Apioninæ	1,060	.	377	Cebrionidæ	223	.	80
Brenthidæ	735	.	276	Pselaphidæ	3,400	.	450
Lucanidæ	750	.	354	Dermestidæ	524	.	194
Lampyridæ	1,109	.	446	Helotidæ	79	.	5
Temnochilidæ	534	.	144	Anthicidæ	1,529	.	424

Im GEMMINGER & HAROLD'SCHEN Katalog sind alles in allem c. 77,000 Coleopteren-Arten registriert gewesen; die Arten-Zahl im neuen SCHENKLING'SCHEN Katalog wird sich voraussichtlich auf 250,000 belaufen! Diese Riesen-Zahl spricht am besten für den Umfang der geleisteten und noch zu leistenden Arbeit, welche in c. 7 Jahren abgeschlossen sein soll.

Solche Unternehmungen wie der vorliegende Katalog können natürlich nur bei breitester Unterstützung von entomologischer Seite glücklich zu Ende geführt werden: dazu gehört aber nicht nur eine entsprechende wissenschaftliche Mithilfe, sondern auch eine pekuniäre, welch' letztere in erster Linie auf Subskription, in zweiter auf Einzelabnahme der ständig heraus-

kommenden Teile beruht. In diesem Sinne wende ich mich daher im Interesse der glücklichen Beendigung dieses grossen Werkes an alle Vertreter von zoologischen und vor allem entomologischen Museen, Instituten, Gesellschaften etc.; ganz besonders aber auch an alle Entomologen. Meine Bitte dürfte umso berechtigter sein, als der JUNK-SCHENKLING'SCHE Katalog weder von einer Akademie noch von irgend einer anderen Korporation unterstützt wird.

ON THE SENSE OF VISION IN INSECTS.

By A. SEITZ, DARMSTADT.

PURSUING the question of "How do insects see the world?" my experiments lead me to conclude that the eyes of many day-flying insects perceive outlines as well as colours in exactly the same manner as, judging from their visible actions, we are forced to assume in vertebrates and man.

In order to prove whether diurnal butterflies are led by their sense of vision or, as is the case with most Heterocera, by smell, I employed models of certain butterflies made of coloured paper, which I exposed in places where I knew males of the same species had to pass when hunting for the females. Thus I noticed at El Kantara, in Algeria, that the top of a range of hills frequented by a yellow, black-margined butterfly, *Anthocharis charlonia* Dup., was the meeting-place of the males, who came here from great distances to mate. Exposing in this place one of the paper butterflies, which I fastened with a pin on the ground, often as many as six males were seen trying at the same time to copulate with it. The maximum distance at which they were attracted was about $2\frac{1}{2}$ metres (= 8 ft.); beyond that the paper model did not seem to have any visible influence.

Moreover, it was plain that the sham butterfly was clearly recognised, for when pictures of other species were substituted they were completely ignored. Thus a paper model of *Pararge megæra*, which species flies in the same place, had no influence whatever upon the Pierid; on the other hand, the more exact the resemblance of the model was to the butterfly *A. charlonia*, the more intense and lasting was the effect produced upon the males.

In order to test the acuteness of their sense of recognition

a graduated series of more or less perfect models was made, differing in size as well as in colour and markings from the real butterfly. Among them were pictures which, although perfectly agreeing with *charlonia* as to colouring and pattern, were thrice the size. While these also attracted a few single males, the latter approached only for an instant and then passed on again, whereas in the case of exact models they remained a considerable time, attempting to copulate, and often returned several times if, being defeated in their purpose, they had flown away.

Another series of paper models, while exactly corresponding to the real butterfly in size and markings, showed different colours. Here it was noticed that the lemon-yellow males always sought out first the lemon-yellow model, and only after finding their efforts in vain, would turn also to differently coloured ones, but in this case only to those which were of a colouring that the human eye also perceives as similar to the colouring of the butterfly, viz. white and pale orange. Brown models had, however, no attraction for them whatever.

It now remained to be seen whether perhaps other senses played some part in bringing about the recognition. The paper models having, during the first series of experiments, been brought to the place in a box which a few days before had contained a female of the species in question, it was thought possible that they might have become impregnated with its peculiar odour and thus be rendered attractive to the males. In order to make sure of this, a new set of models was made and carried to the place in a note-book. As they produced precisely the same effect as the previous ones, we may safely eliminate the sense of smell.

After thus having established the possession of the sense of colour and size, the author proceeded to test the ability of the butterfly to judge form and pattern. In *A. charlonia* copulation takes place in such a way that while the female sits with expanded wings upon a stone, the male, hovering close above it with a fluttering motion of the wings, repeatedly descends quite suddenly upon the back of the female, keeping all the while its head and body parallel to that of its mate.

After the model had thus been kept for some time in the natural position, with its head slightly erect, it was now turned

around at an angle of 180 degrees, so that its head pointed in the direction from which the males came, all of which followed the same course. It could be observed that, after hovering for a little while above the supposed female in a reversed position, they would suddenly turn around as if they were aware of their mistake, so that we are led to assume that they plainly recognised what was head in the model and what was tail. It must be added, however, that by no means all the males that arrived acted thus, but only those which were unusually active and insistent, and that the distance at which recognition took place never exceeded 6 to 10 cm. (2 to 4 in.), whereas in the case of the wrong colour it was more than 2 metres (6 ft.), and abnormal size was perceived approximately at a distance of from $\frac{1}{2}$ to $1\frac{1}{2}$ metres ($1\frac{1}{2}$ to $4\frac{1}{2}$ ft.).

The amount of assistance derived from the sense of touch was tested in the following way: It was noticed that if freshly captured specimens, which had been killed with cyanide of potassium, were fastened in the right position, copulation took place in a normal manner, as far as could be observed; even females that had been taken the day before, and were entirely dry, exerted the same attraction as freshly captured or living specimens. The paper model, however, offering a smooth surface affording no foothold for the males, indicated that the males were not materially aided by touch. As soon as the abdomen of the very accurately cut paper model was turned slightly upwards, it was observed that the males endeavoured to touch it; but although they were not at all shy, and hovered close around the model when it was held in the hand, the quickness of their movements, aided by the blinding sunlight, made it impossible to see whether contact actually took place.

Another observation also proved that in butterflies the sense of touch is not greatly developed. The wind, which on the tops of those hills always blows pretty strongly, in striking the edges of the paper communicated to the wings of the paper models a fluttering or vibrating motion: each time this took place the males present were visibly affected, and renewed their efforts with increasing energy. Having settled on the back of the model, they were so far from resenting being hit by the paper wings which oscillated in the wind, that they became

even more excited and bold, so that it was quite evident that they were unable to distinguish the hard paper from the delicate, soft wings of the real butterfly.

These facts prove the fallacy of the often defended view that insects are very short-sighted or are only able clearly to see objects in motion. Every collector knows that butterflies closely observe their approaching enemy, and often defeat every effort of his to come near them. The representatives of the Genus *Apatura*, *Eunica*, *Parthenos*, and certain species of *Vanessa* (*antiopa*) and *Argynnis* (*pandora*) are decidedly more far-sighted and wary than others. Even when asleep (or rather at rest) their sight is pretty sharp. Thus one may without great difficulty approach from the opposite side a tree on which a *Catocala* or a Geometrid (f.i. *Boarmia*) has alighted, if only one avoids making any noise; but immediately the net, or the hand carrying the cyanide-glass, appears on the side of the tree where the butterfly sits, it takes to its wings. It has been supposed that it is only the act of moving which frightens the insects, but that they are unable to distinguish the objects themselves. While it is certain that butterflies are more frightened by a quick and sudden motion than if we approach carefully and gently, it is no less true that blades of grass, flowers, or branches violently shaken by the wind do not disturb in the least insects resting near by, whereas a hand stretched forth to catch them would at once cause them to fly away. If one carefully pushes a long branch, from the end of which the fresh leaves have not been removed, towards some not excessively shy butterfly (as f.i. *Pieris brassicæ*) sipping the nectar from a flower, one may often touch it or even push it away without its becoming frightened, whereas it would certainly fly away at once if we were to touch it with the fingers. This would indicate in the butterfly a fair amount of ability to recognise the outline of objects, an ability which may at least in principle be compared with that attaching to the eyes of vertebrates; and this leads us to ask further whether also the sense of colour developed in the compound eye may be compared with that of the simple eye. In the case of the human eye ophthalmological experiments have shown that among all colours red can be seen farthest, blue much less far. When once standing,

in South America, at the bottom of a valley densely covered with a blue flowering Papilionaceous plant, I observed some large Pierids (*Catopsilia philea*) rapidly cross the valley at a height of from 30 to 36 ft. above the ground. Between the blue flowering shrubs there were scattered also a few isolated flowers of a very brilliant red, resembling somewhat our geranium; upon these the butterflies would occasionally precipitate themselves from their considerable height, remaining for a short time to sip the nectar. Once attracted from above, they would continue visiting the neighbouring blossoms, especially the blue ones, which they seemed to favour, probably because they constituted the food plant of the caterpillar. It seems obvious that the butterflies, notwithstanding their predilection for these blue flowers, had not seen them from the great height at which they were flying, but, being induced by the more conspicuous red flowers to descend to within 1 or 2 metres (3 to 6 ft.), they were well able to recognise them distinctly. Thus it seems that the eyes of insects also perceive the red colour at a much greater distance than the blue. Any one studying the behaviour of flower-loving insects will be easily convinced that the gorgeous colour and fragrance which we often notice in flowers, as well as their honey, principally serve to attract insects for the purpose of fertilisation, and indeed we are acquainted with some species in which the fact that fertilisation has taken place and the production of honey has ceased is indicated by an immediate change of colour, the object evidently being to keep the insects from wasting their time. But such a colour-signal would be useless if the insects were unable to perceive and interpret its meaning.

There still remains another question to be answered, namely, whether the insects not only distinguish between the different colours, but whether they perceive them in the same way as is the case with the eyes of vertebrates.

As we know that there exist rays, *e.g.* the ultra-violet ones, which are invisible to the human eye, it may be thought possible that the eyes of insects might in this respect be more perfect than the vertebrate eye. Such a view is supported by a well-known experiment, consisting in allowing sunlight to pass through a prism upon the bottom of a box containing a number

of ants. It is at once noticed that the ants, which seem to dislike coloured light, not only get out of the range of the visible spectrum, but also avoid the space beyond the violet filled with the ultra-violet rays. These latter exerting, as is well known, a powerful chemical influence, it may be assumed, however, that it is the chemical rather than the optical action of the ultra-violet light which brings about this curious effect.

In my further experiments I started from the supposition that the ultra-violet rays would be perceived also in composite sunlight; or, an eye which is at all sensitive to them would not remain impassive if subjected to sunlight deficient in those rays, but would probably notice the difference between complete sunlight and a light from which all the ultra-violet rays had been absorbed by means of a proper medium. Glass has this quality, and one would think that an eye sensitive to those rays would surely notice the difference between an open and a closed glass window. I have, however, observed that *Diptera*, as well as *Hymenoptera* and *Lepidoptera*, fail to find in a window divided into a great number of panes those that are open, unless they are guided by a draught of air. It appears therefore evident that these insects have no clear perception of the difference between glass and air. All these results, which go far to show that the difference between the single and compound eye is not one of principle but merely one of degree (as is also the case with the eyes of different species of vertebrates), seem to be opposed by the anatomical structure of the composite eye, which one might suppose would render the physiological process of seeing quite different. With regard to this objection I may be allowed to remark that the very act of seeing, involving the composition, substitution, and transmission of the image, remains as yet absolutely unexplored and unexplained, even with regard to the eyes of vertebrates and man.

The interpretation of the physical image by the mind remains an unsolved riddle, and the ophthalmologist is daily confronted with phenomena which he so far fails to explain. Normally we see only a single image, although we possess two eyes. In a certain disease of the eye we see three images; in another kind of disease the part of the retina reflecting the image of whatever appears in the field of vision is here and there replaced

by a scarred tissue which is unfit for the process of seeing. Now our physical knowledge would lead us to expect in the diseased eye a spotted, perforated, or obscured image of the outer world, whereas in fact it is just as bright and clear and complete as in the sound eye, only the whole image appears a trifle reduced in size (so-called micropsis). No physiologist has hitherto been able to offer an explanation of this fact, which apparently defeats all physical laws; on the contrary, we are forced to acknowledge that we have no knowledge whatever of the psychological act of seeing even in the human eye. Meeting, therefore, in the compound eye with similar difficulties is no reason why we should, on account of some apparent contradictions, doubt observations which may be daily repeated with similar results. In the case of colour-blind people, whose true perception remains absolutely incomprehensible for people with normal sight, we are accustomed to judge their condition from their actions, and to treat all explanations hitherto offered merely as theories not borne out by practice. The same course must for the time being be followed also with regard to the compound insect-eye, of the physiology of which we know nothing whatever. Here it is the experiment we must solely rely on, an experiment we may make on any day and in any place, and for which the first troublesome house-fly may serve as an instructive subject.

BEMERKUNGEN UND NOTIZEN ZUR GEOGRAPHISCHEN VERBREITUNG EINIGER BLUTSAUGENDEN INSEKTEN.

Von Dr. P. SPEISER, LABES.

DER Entomologie werden verschiedenartige Vorwürfe gemacht, indem die einen sagen, keine Insektengruppe sei genügend durchgearbeitet, um als wirklich brauchbarer Beitrag zur Tiergeographie zu dienen, die anderen, dass die entomogeographischen Forschungen zur hypothetischen Konstruktion von Landbrücken führen, die bei genauerer Betrachtung nicht haltbar sind. Wir müssen uns allemal gegenwärtig halten, dass jegliches Naturstudium nur den augenblicklichen Stand wiedergiebt, und müssen selber bereit sein, unsere Ergebnisse immer weiter zu verbessern und zu sichern. Mit besonders grosser Vorsicht sind Untersuchungen zu unternehmen und Ansichten auszusprechen über die sogenannten Verbreitungscentren einer Gruppe, wenn damit deren Ursprungscentrum gemeint sein soll, und ganz ebenso über den Ausgangspunkt der Verbreitung einer bestimmten, wirtschaftlich interessanten Art. In diesem Zusammenhange ist daran zu erinnern, dass die Heimat der Gelbfieber-Mücke, der *Stegomyia calopus* Meig., immer noch im Unklaren ist, von den einen im Antillenmeer, von den anderen in Afrika gesucht wird. Gerade bei den wirtschaftlich wichtigen, mit dem menschlichen Haushalt und Verkehr verbundenen Arten, zu denen ja die Blutsauger in erster Linie gehören, kommen gar zu leicht als störende Einflüsse die Möglichkeiten der Verschleppung in Betracht. Ich führe zwei mitteleuropäische Arten als nach Südamerika verschleppt an: *Stomoxys calcitrans* L. erhielt ich von Herrn P. HERBST aus Concepcion in Chile, und *Hæmatobia stimulans* Meig. von Herrn Professor Dr. LUTZ aus São Paulo, beide Arten in der bisherigen Literatur noch nicht aus Südamerika verzeichnet. Bei beiden aber ist mit

der Fliege zugleich auch die Nahrung dort eingeführt worden, und die Tiere haben an ihrem neuen Wohnorte keinen Mangel zu leiden gebraucht. Gerade für Südamerika ist aber durch Professor BEZZI die interessante Frage aufgeworfen worden, woher denn die dort eingeborenen Blutsauger, die ganz besonders artenreichen Tabaniden aus den verschiedenen Genera um *Pangonia* und *Tabanus*, ihren Blutbedarf decken. Halten wir damit die andere interessante Thatsache zusammen, dass die blutsaugenden *Tabanus*-Arten Nordamerikas, dessen Tierwelt so viele nahe Beziehungen zu der europäischen hat, sämtlich indigene Arten sind, dass keine einzige mit einer europäischen identisch ist, so werden wir zu dem theoretischen Schluss kommen können, dass die Tabaniden dort vielleicht erst in verhältnismässig ganz neuer Zeit sich durch Artbildungen zu dieser Mannichfaltigkeit entwickelt haben. Das ist aber zunächst Theorie und wird durch keine greifbaren und unwiderleglichen Thatsachen erhärtet. Solche Thatsachen besitzen wir aber andererseits über eine andere interessante Blutsaugergruppe, die Gattung *Glossina*, die Tsetsefliege. Diese ist heutzutage rein afrikanisch, fossil aber kennen wir sie aus Nordamerika: Wir vergegenwärtigen uns, dass KOCH die afrikanischen Glossinen mit Vorliebe an Krokodilen saugen sah, und dass heute die Krokodile zwei wesentliche Verbreitungsgebiete haben, eben Afrika und den Süden Nordamerikas, nebst Südasien. Halten wir dann damit zusammen, dass ich es bei meinen Untersuchungen über die Hippobosciden wahrscheinlich machen konnte, dass die an Beuteltieren schmarotzende Gattung *Ortholersia*, die niederst stehende Hippoboscidenform sei, und dass die phylogenetische Aneinanderreihung der Parasiten der Hirschtiere aus dieser Familie und ungefähr ebenso derjenigen der Kamele eine Parallele bietet zu der vermutlichen historischen Ausbreitung dieser Säugetiergruppe, wenn man beide Erscheinungsreihen auf der Landkarte einträgt. Dann wird man die Bedeutung der Wirte für die historische Betrachtung der Blutsauger erkennen, und die Glossinen, die zudem ihrem Flügelgeäder nach sehr alte Formen sind, ebenfalls mit den Sauriern, deren jetzige Reste die Krokodile sind, und ihrer Ausbreitungsgeschichte in Verbindung bringen.

Derartige Theoreme können unsere praktische Arbeit an

den Blutsaugern nimmer schädigen, im Gegenteil kann es nur von Wert sein, auch theoretisch über diese möglichst viel zu wissen. Jedes thatsächliche Wissen aber sollte durch ganz genaue Aufzeichnungen aller Einzelheiten möglichst sicher verwertbar gemacht werden. Als ich die kleine Blutsaugerin *Lyperosia titillans* Bezzi in Westpreussen auffand, entstand wenigstens die theoretische Frage, ob dieselbe, ein eigentlich mediterranes Tier, nicht aus den dalmatinischen Orten, wo sie notorisch vorkommt, und an denen sich eine grössere westpreussische Reisegesellschaft aufgehalten hatte, eingeschleppt sein konnte. Mein Fang aber war früher geschehen, als jener Besuch in Dalmatien. Genaue Aufzeichnungen liessen das nachweisen, und auf deren dringende Notwendigkeit soll nachhaltig hingewiesen werden.

THE PRESENCE OF MAXILLULÆ IN BEETLE LARVÆ.

By GEORGE H. CARPENTER, ROYAL COLLEGE OF SCIENCE,
DUBLIN.

It is nearly twenty years ago since HANSEN (1893) called attention to the morphological importance of the maxillulæ—a minute pair of structures recognisable in the Apterygote insects on the anterior or dorsal surface of the tongue or hypopharynx, with which they are articulated or partly fused basally. HANSEN insisted on the appendicular nature of these maxillulæ, considering them as serially homologous with the jaws and as corresponding with the first maxillæ of Crustacea. Evidence in favour of this view has been brought forward by FOLSOM (1900) and others, so that it has now been accepted by a considerable number of students of the Arthropoda.

Naturally attempts have been made to recognise the maxillulæ in winged insects. HANSEN certified their presence in Dermaptera and Orthoptera; FOLSOM and others have shown that they form the conspicuous lateral lobes on the tongue of Ephemerid larvæ and nymphs, while BÖRNER has called attention (1904) to their existence in the Copeognatha (Psocidæ). The fact that these structures are most easily recognised in the Apterygota, and in such primitive Pterygota as the Ephemeridæ (Mayflies) and the Dermaptera (Earwigs and Hemimerus), suggests strongly that their presence may be regarded as an archaic feature, and the question arises whether they can be recognised at all in any of these more highly organised insects that pass through a “complete” transformation (Endopterygota of SHARP). HANSEN mentions that he could find no trace of them in the Coleoptera.

With regard to beetles in their adult condition, it is likely that no investigator will succeed where HANSEN has failed.

But the larvæ of Coleoptera, on account of the great variety of form which they exhibit, are admitted to be of exceptional morphological interest, and the hypopharynx, with its associated structures, has received but slight attention from students of their anatomy. As is well known, the larvæ of beetles furnish a series showing transition from the "campodeiform" to the "eruciform" type, and many students, following BRAUER (1869), have used these facts as an argument that, in the phylogeny of the Insecta, the active, armoured larva must be more primitive than the legless grub, and that there must have been, in the course of insect evolution, an increasing divergence between the imaginal and larval stages. A "campodeiform" type of beetle-larva might offer, therefore, promising material for study, and in the root-eating grub of *Dascillus cervinus*—numerous specimens of which have lately come into my hands through agricultural inquiries—a type is found in which the larval mouth-appendages differ far less than is usual from the corresponding parts in the adult. In this larva, for example, the maxilla has the typical parts—cardo, stipes, lacinia, galea, and palp well-developed; there is very little of that reduction which characterises the maxilla of an adephagous larva.

In collaboration with my former pupil, Miss M. C. MACDOWELL, I have made a careful examination of the hypopharynx of the *Dascillus* larva, comparing with it the corresponding structures in the aquatic larva of *Helodes* (which belongs also to the Dascillidæ) and in the well-known fleshy grubs of two Scarabæid genera—*Phyllopertha* (the Garden Chafer) and *Geotrupes* (the Dor Beetle). Our descriptions and figures have recently been published (1912). In the *Dascillus* larva, we find, on the dorsal surface of the hypopharynx, two prominent lobed sclerites, which bear each a curved row of strong, blunt teeth. These sclerites are, we believe, true maxillulæ. In the larva of *Helodes*, in the same position, we find homologous structures, which articulate with definite condyles on the hypopharynx, and have a distinct, pointed apex, covered with sensory hairs, and projecting beyond the edge of the labium. The appendicular nature of these maxillulæ is, therefore, more clearly seen in the *Helodes* than in the *Dascillus* larva; the

whole dorsal surface of each maxillula is covered with parallel rows of minute spines, and on its inner edge are found a dozen or more elongate, curved teeth.

These structures had previously been seen and figured—in *Helodes* excellently by ROLPH (1874) and in *Dascillus* somewhat roughly by RIVERS (1891). These authors, however, had no conception of the appendicular nature of the organs which they described. SCHIÖDTE, in his drawings of the larva of *Ateuchus* (1874, Pl. XIV, fig. 8) shows the hypopharynx with a pair of spinous “paraglossæ,” which are evidently reduced maxillulæ. *Ateuchus* belongs to the Scarabæidæ, the family which includes *Geotrupes* and *Phyllopertha*, whose larvæ we also examined. In the *Geotrupes* grub the maxillulæ are apparently present, though fused with the hypopharynx, but in the larva of *Phyllopertha* we can recognise the maxillula on the left-hand side only. Such asymmetry, unusual in the mouth-appendages of insects generally, is very marked in the labrum of *Dascillus* and of *Phyllopertha*. It is noteworthy that in these beetle-larvæ which possess toothed maxillulæ—and especially in *Dascillus*—there are rows of spines on the labrum which work against the maxillular spines, while median labral teeth are opposed to median teeth on the hypopharynx. Thus, in the mouth of these larvæ, there appears to be a dorso-ventral biting or seizing action in the work of feeding.

Since the publication of our paper, further observations have been made on the maxillulæ of beetle-larvæ. SCOTT, in his investigations into the insects living in the wet spaces between the leaf-bases of Bromeliaceous plants in the West Indies, found specimens of a *Helodine* larva, of which he kindly sent me specimens; a short account of this larva, with a reference to its maxillulæ and hypopharynx, may be seen in his recent paper (1912, p. 431). The accompanying figure (fig. 5) of its labium, hypopharynx, and maxillula may be useful for comparison with the corresponding structures in the larva of *Helodes*. There is a general likeness between the parts in the two insects, as might be expected, with some interesting differences in detail.

The labium consists of a flat mentum (M) which carries a pair of palps (p). The front edge of the labium (La) is fringed with a series of long, delicate hairs, and, as usual in coleopteran

larvæ, the front edge of the hypopharynx (H') is united with the labium dorsally, along a definite suture (s). From this front region of the hypopharynx projects a central boss which bears two pairs of strong, bayonet-like spines (sp). (In the

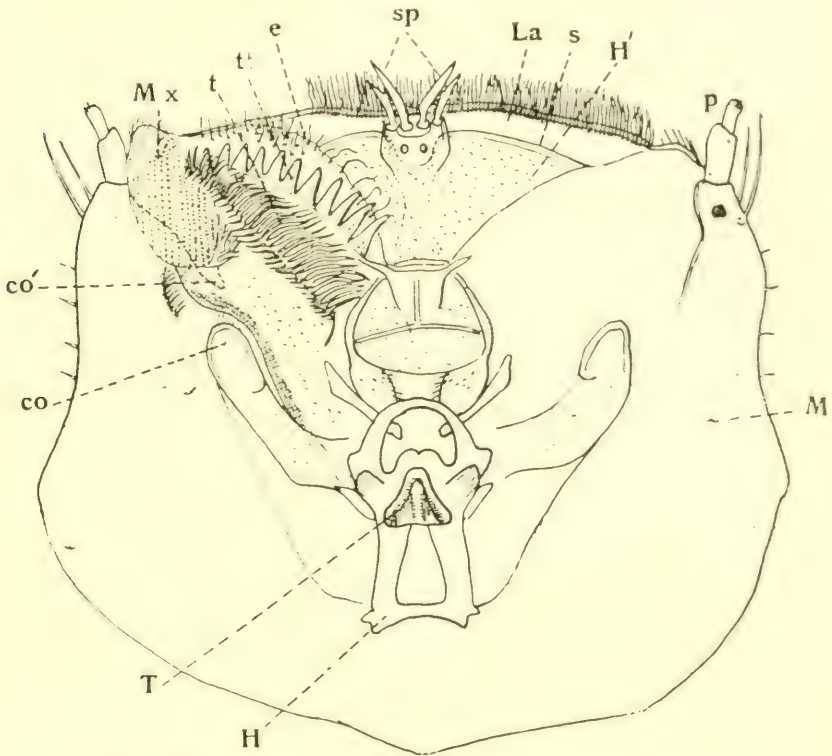


FIG. 5.—Dorsal view of left maxillula (Mx), hypopharynx (H), and labium (M, La) of *Helodine* larva from Dominica (in Bromeliaceæ). T, median tooth on hypopharynx; co, condyle; sp, spines; s, suture between hypopharynx and labium; Mx, outer lobe of maxillula; co', its condyle; t, flexible spines; tt, strong teeth; e, edge of inner lobe of maxillula; La, front edge of labium; M, mentum; p, labial palp. H, base of hypopharynx; H', its front edge. Magnified 100 diameters. A, comb-like teeth on maxillula. Magnified 800 diameters.

Helodes larva, the corresponding spines are bifid at the tip.) While the hypopharynx is fused with the labium in front, its base (H) is markedly dorsal to the labium; in *Dascillus* and the *Scarabæid* larvæ it is separated from the latter by the

ventral sclerite of the head capsule. The base of the hypopharynx carries a strong median tooth (T) which works against teeth on the inner (ventral) aspect of the labrum, as in *Helodes* and *Dascillus*; the vertical masticatory action which apparently takes place in these larvæ is remarkable. Just in front of this tooth, on each side of the base of the hypopharynx, projects a prominent condyle (co), against which rests the base of the maxillula (Mx). The maxillula consists of an outer lobe with blunt apex (in the *Helodes* larva this is acuminate) and beset with numerous rows of minute spines, many of which are comb-like, having three or four blunt denticles (A). Ventral to this lobe the maxillula is prolonged into a somewhat acuminate condyle (co') into which is inserted a delicate muscle arising from the condyle (co) of the hypopharynx. The inner edge of the maxillular lobe is beset with a series of 30 to 40 delicate, flexible spines (t); the corresponding spines on the maxillula of the *Helodes* larva are fewer and stronger. Internal to these a curved row of eleven stout, prominent teeth (tt) is conspicuous. A homologous row of similar teeth in the larva of *Helodes* was believed by Miss MACDOWELL and me to belong to the hypopharynx, not to the maxillula. In the larva now under examination, however, there lies internal to this row of teeth a delicate but perfectly definite edge (e), beset with numerous fine hairs, and united basally with the central sclerite of the hypopharynx. The position and appearance of this edge suggest that it is really the inner margin of the maxillula; if so, the strong teeth (tt) must be regarded as borne on the latter organ.

The larvæ of the Dascillidæ and Scarabæidæ already described have the mouth-parts—as in the great majority of beetle-grubs—adapted for biting solid food. It is noteworthy that MANGAN has lately (1912) recorded the presence of maxillulæ in some larvæ of the carnivorous water-beetles (Dyticidæ)—*Dyticus* and *Ilybius*—which have the mandibulate mouth specially modified for taking food by suction. In these insects the maxillula consists of a small pointed or rounded prominence, situated internal to the mandible and dorsal to the maxilla. In *Dyticus* at least it is far removed from the labium or the hypopharynx. I have made a preliminary examination of

the mouth-parts of a larva of *Pterostichus*, belonging to the Carabidæ, a family closely allied, as is well known, to the Dyticidæ, but in whose larvæ the jaws are adapted for biting and not for sucking. Here (see fig. 6) the hypopharynx (H) is not fused distally with the labium (La), which projects far beyond it. The position of the hypopharynx is distinctly dorsal to that of the base of the maxilla (Ma); between the two structures there is on each side a rounded lobe beset with long, flexible hairs (Mx), set somewhat obliquely, and evidently corresponding to the process which, in *Ilybius*, MANGAN has identified as the maxillula. Its

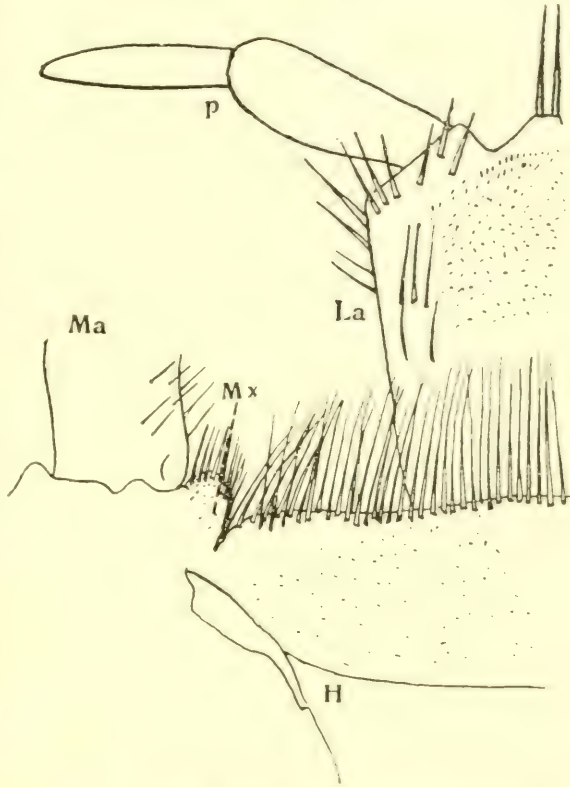


FIG. 6.—Dorsal view of half hypopharynx (H) and labium (La) of *Pterostichus* larva, with base of left maxilla (Ma) and maxillula (Mx). Magnified 75 diameters.

clear association with the hypopharynx in *Pterostichus* strongly supports such an identification, and we may hopefully anticipate that students of insect anatomy will find these interesting appendages in beetle larvæ of other families.

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SUPPLEMENTARY NOTE ON THE POSSIBLE EXISTENCE
OF MAXILLULÆ IN SOME DIPTERAN LARVÆ.

IN the paper by CARPENTER and MACDOWELL (1912), referred to above, the identification of the maxillulæ is stated to be “the first recognition, as we believe, of these interesting appendages in any stage of an Endopterygote (metabolic) insect.” My friend Mr. J. MANGAN has, however, since called my attention to the work of BENGTSOON on the larva of the tipuloid fly *Phalacrocera*,¹ in which an “endolabium,” bearing paired lobes homologised with the maxillulæ of Apterygota, is described and figured; it is further stated that this “endolabium” is innervated by a special nerve arising from the front region of the sub-oesophageal ganglion. BENGTSOON’S results have, however, been somewhat severely criticised by

¹ *Acta Reg. Soc. Physiogr. Lund.*, viii., 1897, and *Zool. Anz.*, xxix., 1905, pp. 457–76.

HOLMGREN,¹ who states that the "ectolabium" of BENGTTSSON is the mentum of a typical labium, and that the supposed "endolabium" represents the galeæ and laciniae thereof; all these structures are, according to HOLMGREN, supplied by the labial nerve, BENGTTSSON'S "endolabial nerve" being in reality a muscle-fibre. The existence of maxillulæ among the larvæ of Diptera must, therefore, be regarded as exceedingly doubtful.

¹ *Zeitsch. f. wissenschaft. Zool.*, lxxvi., 1904, pp. 439-77, and *Zool. Anz.*, xxxii., 1907, pp. 73-97.

A PLEA FOR THE CENTRALISATION OF DIAGNOSTIC DESCRIPTIONS.

By E. ERNEST GREEN, F.Z.S., F.E.S., Entomologist to the Government of Ceylon.

OF the making of names (*i.e.* the publication and description of new genera and species) there is no end. In the 150 years since the date of Linnæus's adoption of binominal nomenclature, far from having exhausted the subject, new species of animals are being described in ever-increasing numbers. The latest volume of the *Zoological Index* (that for 1910) lists some 15,000 fresh names of Insects alone.

The mere multitude of descriptions with which the systematic entomologist must make himself familiar renders his work sufficiently arduous; but when, to the number, is added the fact that they are scattered throughout hundreds of distinct publications—many of them obscure and difficult of access—the task of the conscientious student becomes stupendous. Moreover, the difficulty of examining every diagnosis, and the feeling of hopelessness that it engenders, tends to accentuate the trouble by encouraging a careless multiplication of synonyms.

Until we either return to compulsory Latin diagnoses (which are far from satisfactory), or adopt some universal international language capable of more subtle gradations of expression, we cannot avoid the lingual difficulty. But a vast saving of time and energy (and even expense) could be effected by the adoption of a judicious system of centralisation in each country. How much weary searching through out-of-the-way journals, how many tiresome journeys to public libraries, what annoying delays in the endeavour to obtain copies of obscure papers, would be avoided if every country had some recognised medium for the publication of all new diagnoses!

I am aware that, though this plan seems simple on the surface, many difficulties would crop up in practice; but I do not believe that they would be insurmountable. Though it is of equal concern to all zoologists—and botanists also—I prefer to open the matter for discussion from the entomological standpoint alone—to keep it within the scope of the Congress of Entomology.

To ascertain what the difficulties may be, it will be necessary to outline a supposititious scheme and see how it would work. The following scheme is put forward solely for this purpose—and to excite discussion. I do not even suppose that it is original. I believe that some such arrangement has been mooted previously—and dropped. But many good schemes have been adopted finally—after repeated rejections.

Let us suppose that each country should agree to establish a single journal in which all new diagnoses submitted to it should appear, and that no new name should be accepted until it had appeared (with a suitable diagnosis) in such journal. The contents of these special journals should be purely diagnostic, but references might be given to other papers dealing with biological matter and other observations of interest relating to the species concerned. The diagnoses should be written in certain specified languages—say, Latin, English, or French. These diagnostic journals should not be privately owned concerns, but should be managed and financed by a committee of the Entomological (or Zoological) Societies of their respective countries. They should be published at a price calculated merely to cover the cost of production, and issued in sections, so that specialists might (if they so wished) subscribe for the particular sections only in which they were specially interested. They should appear at frequent and not necessarily regular intervals—in fact, as often as sufficient material to fill a fascicle of a recognised number of pages has been received for publication. Contributions sent in for publication should be dated on receipt and printed strictly in that order. Thus, in the possible event of the same species being described under different names in the same fascicle, the one appearing on the earlier page will have priority. In the case of separately published monographs, dealing with a large number of species, a simul-

taneous publication—in the Diagnostic Journal—of the names of new genera and species (without diagnoses) should be considered sufficient for acceptance; but this exception should be limited strictly to separately published monographical work, and not be extended to such cases as publication in the Proceedings of Societies or the inclusion of new descriptions in the midst of some general work. New names, in cases of preoccupation, might also be accepted without a repetition of original diagnoses; but full reasons for the proposed changes should be given, together with references to the original descriptions. Figures, if required by the author, should be published only at his expense, and might, perhaps, be prohibited altogether, on the score of delay. Full illustrations, with ampler descriptions, might be published in other journals. Publication in the special journals need not prevent the appearance of other (possibly more amplified) descriptions elsewhere; but the name should carry the date of its publication in the Diagnostic Journal, even though it may have appeared previously in some other publication. Any such rule could not, of course, be retrospective. The Journal could be indexed at the end of each year, and would constitute an Entomological Record for publications in that country. The choice of any particular Diagnostic Journal, for publication, would be optional.

We may now consider objections that may be brought forward against the proposed scheme. In discussing it with other biologists, I find that the first inclination is to waive it aside as hopelessly impracticable; but, when pinned down to formulate their objections, all that they can bring forward is the question of vested interests, and this objection I believe to be fallacious. Why should the adoption of such a scheme prejudice, as has been suggested, the existing journals and publications of various Societies? In the opinion of many naturalists, such publications would be vastly relieved by the omission of strings of new names and weary pages of purely diagnostic matter. On the other hand, more space would be afforded for the description of life-histories and other interesting biological observations, which would assuredly make them more readable. Many authors, also, would publish, in the Proceedings of Societies or elsewhere, fuller and less formal descriptions

(accompanied by figures) than would be suitable for the central journals. I see no reason why the adoption of this scheme should necessarily cause the failure of any existing journal (though I am strongly of opinion that there are too many of them).

The advantages of the scheme are self-evident: amongst others, it would tend to reduce the production of fresh synonyms and would greatly simplify questions of priority.

If it should be considered that the scheme, in its entirety, would be impracticable (though I am not prepared to admit this), or too revolutionary, on the grounds that "half a loaf is better than no bread" a commencement might be made by the mere registration in special journals of all new names, with references to their origin, such registration being compulsory for acceptance. The *Zoological Record* falls short of this in that registration therein is not compulsory. Moreover, that publication is—of necessity—delayed until many months after the appearance of the names in question. Registration in the special journals should be made as nearly simultaneous with the original publication as possible, and the issue of the fascicules should be at short intervals.

I am fully conscious that my suggestion is crude and lacking in important particulars, but if it should be thought worthy of further consideration, it would be within the functions of the Congress to appoint a small committee to weigh the pros and cons and to discuss the matter in greater detail.

MIMICRY IN THE TWO SEXES OF THE EAST AFRICAN LYCÆNID, *ALÆNA PICATA* E. M. SHARPE.

By K. ST. AUBYN ROGERS, MOMBASA.

MANY cases of mimicry amongst African *Lycænidae* are well known, most of which are found amongst the *Lipteninae*. The reason for this is that this large group, or at any rate many genera of it, have quite different habits from the more typical Lycænids. They are almost entirely confined to forests, and do not frequent flowers. They may usually be seen floating about in sunny openings, or settling on the branches of trees with the wings hanging down.

The species which is the subject of this note is remarkable for its marked sexual dimorphism, which is very unusual in the subfamily. The female was first described, and was named by Miss SHARPE *Alæna picata*. This is a small black-and-white insect, and although the distribution of the markings is rather different from those of any *Neptis* which inhabits the same district, still the floating character of its flight gives it a very marked resemblance to this genus on the wing, and it is not easy, at first, to distinguish it from some of the smaller specimens with which it flies.

The male, on the other hand, which has more recently been called *Alæna vollei*, has all the light markings bright fulvous, and their distribution differs somewhat from those of the female. It bears a general resemblance to a small *Acræa*.

This sexual dimorphism is excessively rare in the whole subfamily of *Lipteninae*, and it is of great interest that it appears to be connected with mimicry of butterflies belonging to different subfamilies.

There can be little doubt that the two forms are male and female of the same species. On the underside the resemblance is very close. They come from the same locality, whereas no other species of the genus is known from the district, and the white-marked specimens are always female and the fulvous-marked specimens always male.

RECENT WORK IN ECONOMIC ENTOMOLOGY CARRIED OUT IN WESTERN AUSTRALIA.

By Sir N. J. MOORE, Agent-General for Western Australia,
London.

INSECT PESTS IN WESTERN AUSTRALIA: PROVISION MADE TO DEAL WITH THEM.

The measures taken in Western Australia to deal with insect pests inimical to plant life are divided into two branches—the prevention of entry, and the internal field-work.

Prevention of Entry.

The Insect Pest Amendment Act of 1898 restricts the ports of entry for fruit and plants into Western Australia to two. This enables a skilled staff of inspectors to scrutinise carefully all fruit and plants imported into the State, and where they deem necessary to destroy or to disinfect, which they have power to do under the law. The importation of plants infested with such parasites or diseases as Codlin Moth, Mussel Scale, Fruit Fly, *Phoma citricarpe*, *Phylloxera*, and other pests declared from time to time to be pests under the Act, is absolutely prohibited. The inspection-work carried on at the ports of entry have been very careful and successful, and since the passing of the Act has prevented the entry of Codlin Moth, *Phylloxera*, etc., although infected plants and fruits have constantly been discovered at the ports and promptly dealt with as described. Codlin Moth made its appearance, however, but it has been stamped out as a result of the field-work and insistence on internal precautions.

The Field-work.

The inspection at the ports has been supplemented by an elaborate system of field-work. An expert staff of field-inspectors is employed in combating disease already within the State. Their sole duty is continuously to inspect the orchards and vineyards in their respective districts. As a result of this

work the Agriculture Department reported in 1905 that Codlin Moth, which had been detected in seven gardens in Perth in 1903, had been completely stamped out. The chief diseases or parasites from which the fruit industry suffers are various scale diseases and the Fruit Fly. In 1902 extraordinary measures were taken to deal with these pests in the appointment, in conjunction with the Californian Department of Agriculture, of Mr. George Compere, a Californian entomologist, to seek out parasites inimical to the pests which were productive of disease in the fruit.

Mr. Compere's Work.

Mr. Compere has visited many parts of the world in the prosecution of his mission. His first task was to secure in New South Wales and Queensland the internal parasites of the Black Scale and Cabbage Aphis, and the ladybird which preys on the Mealy Bugs, which had already saved from ruin the coffee-planters and orange-growers of Honolulu, and the pine-apple growers of Queensland and the Cape of Good Hope. Two useful species of *Rhizobius* were induced to combat the Black Scale, and two other ladybirds, both scale-eaters, and another ladybird from Tasmania. Specimens of the Aphis-feeding species were also introduced.

The Fruit Fly, the San José Scale, and the Red Scale are the most serious fruit-diseases in Western Australia. The Black Scale is no longer regarded as serious, as it is completely under the control of its parasites. The same remarks apply to the Soft Brown Scale. The various scale-parasites have been continuously successful and, as the Assistant Entomologist states in a full report on this subject, it is impossible to place a monetary value on these insect friends. Take a single instance, the Black Scale: this has not only been checked for the present, but for all time, as, once a parasite is established in a country, it is permanent, and the cost of labour, time, and spraying is also saved for all time. But the efforts to establish the Fruit Fly parasites have been disappointing.

During 1910, 50,000 of them were liberated in various orchards. They appeared to thrive for a time, but eventually disappeared. The Fruit Fly is still the worst insect pest in the

State, but the Chief Inspector for Insect Pests reported in 1916 that amongst careful orchardists it was doing little damage. The growers co-operate in efforts to combat this pest, and, although the parasite has failed to establish itself, the use of kerosine traps and the grubbing up of useless trees is tending to keep the pest under reasonable control.

Fruit Fly Eradication.

A communication, dated May 4th, 1912, has only recently been received by the Agent-General from the Lands Department in Western Australia, enclosing a letter of advice issued to orchardists by the acting Fruit Inspector of Insect Pests, in which this officer states that it has been already demonstrated, in several districts in the south-western portion of Western Australia, that by carefully watching and judiciously handling all winter fruits it is possible not only to reduce Fruit Fly to harmless proportion but actually to eradicate it entirely from a whole district. The inspector firmly believes that the same result can be achieved anywhere, provided all those who have winter fruits in their possession take special care to prevent those fruits from providing the pest with a "carry-over" from season to season. To do this all that is necessary is to examine the fruit frequently throughout the months of June, July, August, and September, and, as soon as any larvæ are found, the trees should be stripped, all infested fruit should be destroyed, and all sound fruit stored or marketed.

A campaign has been planned for the present winter with a view of carrying out these ideas, and the assistance and co-operation of all fruit-growers in districts infested with Fruit Fly is being enlisted.

Advice by latest mail states that a public meeting is to be held at Guildford, Western Australia, for the purpose of fully discussing methods to be adopted.

A petroleum emulsion wash has also been found efficacious in the case of the San José Scale. Parasites of the Red Scale have not yet been sufficiently established to combat this pest, and spraying and fumigating have to be systematically resorted to.

A report by Mr. F. STOWARD, Botanist and Pathologist, is appended.

REPORT BY MR. F. STOWARD, BOTANIST AND PATHOLOGIST
OF THE AGRICULTURAL DEPARTMENT OF WESTERN AUSTRALIA.

THE chief insect pests dealt with, and the preventive and combative measures recommended and applied, may be conveniently enumerated under the following headings :

- (a) Cereal and stored-food pests.
- (b) Field-crop insect pests.
- (c) Orchard insect pests.
- (d) Animal insect pests.

The names given in each case are the casual and scientific names respectively :

(a) *Cereal and Stored-food Pests.*

1. Flour Moth (*Asopia farinalis*).
2. Mediterranean Mill Moth (*Ephestia kuehniella*).
3. Grain Moth (*Gelechia cerealella*).
4. Grain Weevils :
 - (a) Wheat Weevil (*Calandra granaria*).
 - (b) Rice Weevil (*Calandra oryzae*).
5. Flour Beetle (*Tribolium ferrugineum*).

The combative means recommended and employed with success is fumigation of infested material with carbon bisulphide, and subsequent suitable storage conditions.

(b) *Field-crop Insect Pests.*

1. Potato Moth (*Gelechia opercuella*).
2. Cabbage Moth (*Plutella cruciferarum*).
3. Cutworm Moths (2 spp.) (*Heliothis armigera*
and *Agrotis munda*).
4. Cabbage Aphis and Turnip Aphis (*Aphis brassicae*).
5. Rutherglen Bug (*Nysius vinitor*).

The combative measures used against pests other than the Potato Moth are (2, 3, and 4) spraying, baiting, and hand-picking. In the case of pest 5 the measures recommended rely mainly on farm-sanitation, deep, thorough cultivation, and the

burning off of infested stubble, and also the use of repellent chemical substances.

(c) *Orchard Insect Pests.*

1. Fruit Fly (*Ceratitis capitata*).
2. Black Scale (*Lecanium olea*).
3. Brown Scale (*Lecanium hesperidum*).
4. Red Scale (*Aspidiotus aurantii*).
5. San José Scale (*Aspidiotus perniciosus*).
6. Mussel Scale (*Mytilaspis pomorum*).
7. Cottony Cushion Scale (*Icerya purchasi*).
8. Vine Scale (*Lecanium cymbiforme*).
9. Greedy Scale (*Aspidiotus rapax*).
10. Woolly Aphis (*Schizoneura lanigera*).
11. Peach Aphis (*Aphis persica*).
12. Orange Aphis (*Siphonophora citrifoli*).
13. Apple Aphis and Pear Aphis (*Aphis mali*).
14. Pear Slug and Cherry Slug (*Selandria cerasi*).
15. Red Spider (*Tetranychus telarius*).
16. Red Mite (*Bryobia pratensis*).
17. Cherry Borer (*Cryptophaga unipunctata*).
18. Tussock Moth (*Orgia postica*).

The combative measures relied upon as applied to pests 2-9 are either spraying with repellent or contact solutions or mixtures, or fumigation with hydrocyanic gas. Introduced parasites have been successfully used in the case of pests 2 and 3, partially in the case of 4 and 8. Pests 6 and 7 are almost completely held in check by native parasitic insects. All the various aphid-pests, with the exception of that on the cabbage, are in large measure kept under by spraying. The means usually relied upon for the destruction of the Cherry Borer is to plug the borings with cotton-wool saturated with carbon-bisulphide.

(d) *Animal Insect Pests.*

1. Blowflies :

- (a) Bluebottle Fly (*Lucilia sericata*).
- (b) Common Blowfly (*Calliphora villosa*).

2. Cattle Tick (*Boophilus australis*).

3. Bot Fly (*Gastrophilus equi*).
4. Fowl Tick (*Argas persicans*).
5. Sheep Tick (*Melophagus ovinus*).

The methods of treatment in 1, 2, and 5 are the dipping of infested animals in approved cattle-dips—usually arsenical dips and destruction by burning of all carcasses. Remedial measures essayed in 3 and 4 are the employment of protective dressings and repellent solutions. In the case of (4) the use of tick-proof perches, the disinfection of fowl-sheds, and general improvement of sanitation of houses and runs are the chief means employed.

The work of the entomological section of the Department embraces :

1. The identification of insect pests of economic importance and interest.
2. The preparation and distribution of entomological collections of interest to the various horticultural, agricultural, and pastoral organisations.
3. The introduction, breeding, and distribution of beneficial insects.
4. The dissemination of information in regard to the various insect pests enumerated, and the best means of preventing their ravages.
5. The preparation and publication of Bulletins bearing on insect pests, with a view to affording the settler useful information on these subjects.

The orchards of the State are free from Codlin Moth. Reference must be made to the fact that on four occasions outbreaks of this pest have occurred, the insect having been introduced with imported fruits from the Eastern States.

On each occasion the outbreak was detected early, localised promptly, and successfully dealt with.

In addition I desire to give prominence to the fact that original investigations into the Fruit Fly, Potato Moth, and Grain Weevil have been in progress for some time past, and the results are nearing publication.

Each inquiry embraces the economic study, under local conditions, of the pests referred to, and includes the devising of combative measures for their suppression.

F. STOWARD, Botanist and Pathologist.

SEX-LIMITED INHERITANCE IN INSECTS.

By L. DONCASTER, CAMBRIDGE.

IT is now generally recognised by students of Mendelian inheritance that, of any pair of characters, the dominant character is due to the presence of a "factor" which is absent in the case of the recessive character. The essence of sex-limited inheritance is that the individuals of the sex in which sex-limited transmission occurs transmit the positive ("present") factor to offspring of one sex only; e.g., in the case of *Abraxas grossulariata*, if G be the factor for *grossulariata*, g (= absence of G) that for *lacticolor*, then the heterozygous female Gg transmits G only to her male offspring, thus:

$$\begin{array}{c} Gg \text{ ♀} \times gg \text{ ♂} \\ \swarrow \quad \searrow \\ gg \text{ ♀} \quad Gg \text{ ♂} \end{array}$$

A heterozygous male, on the other hand, mated with a *lacticolor* female transmits G to offspring of both sexes, thus:

$$\begin{array}{c} gg \text{ ♀} \times Gg \text{ ♂} \\ \swarrow \quad \downarrow \quad \searrow \quad \swarrow \\ Gg \text{ ♀} \quad gg \text{ ♀} \quad Gg \text{ ♂} \quad gg \text{ ♂} \end{array}$$

It appears, in fact, that eggs in this species which will develop into females can never bear G , wild females having the constitution Gg .

In his recent papers on the inheritance of several characters in *Drosophila ampelophila*, Prof. T. H. MORGAN has shown the existence of sex-limited inheritance of the converse type, in which it is the male which always transmits certain characters to his daughters; e.g. a white-eyed male appeared in his cultures, and from this a white-eyed strain was built up. It then appeared that when a normal (red-eyed) male was mated with

a white-eyed female all the female offspring were red-eyed, all the males white-eyed, thus— R being red, r white (absence of red):

$$\begin{array}{c} rr \text{ ♀} \times Rr \text{ ♂} \\ \swarrow \quad \searrow \\ Rr \text{ ♀} \quad rr \text{ ♂} \end{array}$$

But the converse cross, heterozygous red female by white male, gave red and white in each sex, thus:

$$\begin{array}{c} Rr \text{ ♀} \times rr \text{ ♂} \\ \swarrow \quad \downarrow \quad \searrow \quad \swarrow \\ Rr \text{ ♀} \quad rr \text{ ♀} \quad Rr \text{ ♂} \quad rr \text{ ♂} \end{array}$$

A number of other sex-limited characters have also been discovered in this species by MORGAN.

Two questions of great theoretical importance arise from these cases, both concerned with the nature of sex-determination.

1. In both plants and animals (including *Drosophila* itself), it is known that "coupling" may occur in the gametes between factors for distinct characters, in such a way that characters which are associated in the parent tend to be associated in the gametes of the offspring. If A and B are two such characters, a and b representing their absence, then it is found that when an individual containing A and B is mated with one of constitution ab , the gametes of the offspring show an excess of the combinations AB and ab , and a deficiency of aB and Ab , and the ratios in which they occur, in plants at least, show a certain regularity, thus:

	Parents $AB \times ab$			
	Offspring $ABab$			
	AB	Ab	aB	ab
Ratios gametes produced by $ABab$ in various cases	3 7 15 31	1 1 1 1	1 1 1 1	3 7 15 31
	etc.			

In the cross between the combinations Ab and aB , although the offspring are identical with those from $AB \times ab$, there is an inversion of the ratios in which the factors are associated, thus:

$Ab \times aB$			
$AbaB$			
AB	Ab	aB	ab
1	3	3	1
1	7	7	1
1	15	15	1
1	31	31	1
etc.			

In animals it is not certain that the ratios $3 : 1$, $7 : 1$, etc., are followed.

In no case of this kind is it certain that *absolute* coupling occurs between the associated factors. Now there is very strong evidence that the sex-determining factors behave as a pair of Mendelian characters, and that sex-limited inheritance is a special case of gametic coupling of the type illustrated; it is therefore of importance to determine whether it is absolute or partial, as in the cases referred to. In pigeons and canaries partial sex-limited inheritance is known to exist; in *Abraxas* and *Drosophila* there is as yet no certain evidence that the coupling with the sex-factor is not absolute, although certain exceptions which have been recorded point to the possibility of its existence. It has been suggested, however, that the distribution among the sexes of the forms *tau* and *lugens*, in the well-known experiments of STANDFUSS on *Agria tau*, indicated partial sex-limitation in that species.

2. A still more important theoretical question arises from a comparison of *Abraxas* and *Drosophila*. In *Abraxas* it is clear that the sex must be determined in the egg before fertilisation, since the factor G is transmitted only to those eggs which will become males. In *Drosophila*, however, the same reasoning suggests that it must be the spermatozoon which

determines the sex, since the factor R is transmitted by the male only to his female offspring. American writers have correlated this fact with the discovery that in the male of *Drosophila* there is one heterochromosome, transmitted to only half the spermatozoa, while in the female there are two, so that one is transmitted to every egg. They assume that an egg fertilised by a spermatozoon bearing a heterochromosome becomes a female, one by a spermatozoon lacking a heterochromosome becomes a male, and that sex-limited characters are borne by the heterochromosome, and thus transmitted by the male only to his daughters. This view, though very simple, has certain disadvantages:

(a) It involves the assumption that in Moths and Birds, which have sex-limited inheritance of the *Abraxas* type, the sex is determined by the egg, while in Diptera and Man, where the *Drosophila* type is found, the spermatozoon determines the sex.

(b) There is also evidence that in Birds there is a single heterochromosome in the male, as in *Drosophila*; and also that the sex-ratio in *Drosophila* is strongly influenced, if not determined, by the female parent.

(c) Finally, there is some evidence, not perhaps very satisfactory, that in species in which there is absolute sex-limited transmission in one sex, there may also be a slight degree of sex-coupling in the other, e.g. that while the male Aa transmits the factor A only to his daughters, the female Aa may produce an excess of $A\text{♀}$ and $a\text{♂}$ gametes, and a deficiency of $A\text{♂}$ and $a\text{♀}$. If this should prove to be so, it is impossible that the sex in such a case can be determined only by the spermatozoon. It is therefore of great importance that further cases of sex-limited transmission should be discovered, in order that these questions may be further elucidated, and it appears probable that some insect which may be bred in quantity and with rapidity is the form which is most likely to provide the material which is required.

Note added June 1913.

With regard to paragraph (b) above, MORGAN has shown (*Science*, vol. 36, Nov. 1912, p. 718) that the apparent influence

of the female parent on the sex-ratio of *Drosophila* is explicable on the hypothesis that the spermatozoon determines the sex; and a further investigation of the cases referred to under (c) has not supported the suggestion that partial coupling in one sex may co-exist with absolute sex-limited transmission in the other.

NÉCESSITÉ DE L'EMPLOI DU LATIN POUR LES DESCRIPTIONS.

Par E. OLIVIER, MOULINS.

JE viens simplement appeler l'attention sur l'emploi du latin dans les descriptions, et je voudrais que cette langue ne soit pas abandonnée, comme beaucoup d'auteurs ont tendance à le faire actuellement, mais que son usage soit, au contraire, généralisé autant que possible pour toutes les publications scientifiques.

J'accepte bien que les auteurs donnent dans leur langue une description minutieuse et détaillée des insectes qu'ils veulent faire connaître, mais je crois très utile que cette description soit toujours précédée, comme le faisaient les anciens, d'une courte phrase ou diagnose, écrite en latin, présentant en quelques mots les caractères essentiels et différentiels de l'espèce.

Cette diagnose fournit la base d'un premier examen, permettant de juger rapidement si l'insecte que l'on désire déterminer a quelques rapports avec celui qui est décrit, et d'après les cas, on abandonne ou on poursuit la comparaison avec les caractères détaillés qui suivent, comparaison toujours longue et entraînant une grande perte de temps.

Le latin est, du reste, la véritable langue scientifique, dont la connaissance est indispensable pour la lecture et la compréhension des anciens auteurs, qui l'ont toujours employé. Sa syntaxe est simple et facile et se prête très bien à la plus stricte concision, et son usage n'éveille la susceptibilité d'aucun peuple.

D'autre part, les progrès de l'étude des insectes sont considérables et il se fonde journallement dans toutes les parties du monde des recueils scientifiques écrits dans leurs idiomes nationaux, et l'entomologiste, quelle que soit sa science de polyglotte, peut se trouver en présence de mémoires qui restent com-

plètement incompréhensibles et dont il est forcé de ne pas tenir compte.

Cet inconvénient, qui prive d'une juste notoriété des travaux souvent méritants, serait en partie évité si leurs auteurs adoptaient la pratique de la diagnose latine.

L'entomologiste consciencieux qui reconnaîtrait dans cette diagnose des caractères paraissant s'appliquer à l'insecte qu'il a en mains, s'arrangerait alors pour pousser plus loin sa confrontation en traduisant ou en faisant traduire la description qui, sans le secours de la phrase latine, resterait complètement ignorée.

C'est à nous, entomologistes allemands, anglais, et français, dont les langues sont généralement comprises partout, à prêcher d'exemple en employant toujours le latin dans nos descriptions, ne serait-ce que dans une courte diagnose caractéristique précédant l'exposé de l'examen détaillé des différents organes.

DIE PHYSIOLOGIE IN DER SCHÄDLINGSFORSCHUNG

Von J. DEWITZ, METZ.

WIE sehr auch die angewandte Entomologie in den letzten Jahren an Umfang und Bedeutung zugenommen hat, so lässt sich doch nicht in Abrede stellen, dass sie sich bisher nur in ganz bestimmten Bahnen bewegt hat und daher Gefahr läuft, einseitig zu werden. Denn sie befasst sich zur Zeit fast ausschliesslich mit der Feststellung der Lebensgeschichte, mit den Parasiten und den empirisch gefundenen Bekämpfungsmitteln der schädlichen Arten. Die physiologische Erforschung des Gegenstandes ist aber grösstenteils vernachlässigt worden. Und doch sollte sie den Ausgangspunkt und die Basis für die Lösung vieler praktischer Fragen bilden, denn sie würde uns oft mehr als die andern Forschungsmethoden gestatten, in das Wesen des Gegenstandes einzudringen. Unter diesen Verhältnissen dürfte es nicht uninteressant sein, wenn ich für einige Fälle, mit denen ich mich mehr oder minder speziell beschäftigt habe, die Rolle der Physiologie erwähne.

I. DIE TROPISMEN.

Während in der Botanik die Tropismen schon lange ein eingehendes Studium erfahren haben, ist ihre Erforschung im Tierreich noch verhältnismässig neuen Datums. Meines Wissens stammen die ersten Mitteilungen über sie von den Personen, die sich mit dem Chemotropismus der Leukozyten beschäftigt haben, von mir (4) und von HERMANN (17). Später hat dann LOEB eingehend die verschiedenen Tropismen studiert. Der uns hier am meisten interessierende von den Tropismen ist der Phototropismus, denn auf ihm beruht die seit langer Zeit geübte Methode des Fangens und Vernichtens schädlicher Insekten durch künstliche Lichtquellen. Aber trotz der hohen

Ausbildung, zu der, was die äussere Seite des Gegenstandes angeht, der Lichtfang gelangt ist, und trotz der grossen Anzahl von Arbeiten, welche er hervorgerufen hat, haben sich sehr wenige von den letztern von wissenschaftlichen Gesichtspunkten leiten lassen. Vor allem ist es merkwürdig, dass man die verschiedenartigsten künstlichen Lichtquellen benutzt hat, ohne dass man diese bis auf ganz vereinzelte Ausnahmen auf der einen Seite spektroskopisch auf ihre Zusammensetzung geprüft und auf der andern Seite die Anziehung der verschiedenen Strahlengattungen für die verschiedenen Insekten untersucht hätte. Aehnlich liegen die Verhältnisse für die photometrische Bestimmung der Stärke des angewandten Lichtes, da man sich im allgemeinen auf unbestimmte Angaben wie starkes, strahlendes, gedämpftes usw. Licht beschränkt.

Ein grösseres praktisches Interesse bietet die verschiedene Anziehung, welche das künstliche Licht auf die Geschlechter ausübt. Wenn auch in dieser Hinsicht verschiedene Personen, welche den praktischen Lichtfang ausführten, darauf bedacht waren, das Geschlecht der gefangenen Insekten zu bestimmen, so konnte man aus solchen Angaben doch auf keine Gesetzmässigkeit schliessen. Eine solche vermochte ich (8) zum ersten Male aus Versuchen zu folgern, welche ich längere Zeit mit Acetylenlampen anstellte. Ich konnte dabei feststellen, dass die Prozentzahlen der gefangenen Weibchen von den Bombyciden zu den Mikrolepidopteren an Grösse zunahmen und dass sie in den verschiedenen Fängen das Bestreben hatten sich in jeder Schmetterlingsgruppe einer bestimmten Zahl zu nähern. Bei den Bombyciden war es die Zahl 4, bei den Noctuen 19, bei den Geometriden 27, und bei den Mikrolepidopteren 38. Die letzten drei Zahlen unterschieden sich durch eine Differenz von etwa 10 und die erste Zahl ist etwa die Hälfte von 10. Für die Mikrolepidopteren der Rebe ist dann von mir (15) und J. LABORDE (18) diese Regel bestätigt worden.

Die Art der Nahrungsaufnahme kann gleichfalls durch den Phototropismus geregelt sein, wie der an der Larve der Kirschblattwespe (*Eriocampa adumbrata*) von E. MOLZ (20) beobachtete Fall zeigt. Diese Larve ist bestrebt, ihre Rückenseite senkrecht zu den einfallenden Lichtstrahlen einzustellen, was zur Folge hat, dass unter natürlichen Verhältnissen die Tiere

fast ausschliesslich auf der Oberseite der Blätter angetroffen worden.

Es sei ferner nur angedeutet, wie der Phototropismus den vollkommenen Tieren oder deren Larven vorschreibt, ihren Wohnort bald in der Erde oder unter Steinen, bald auf der Oberfläche zu wählen oder sich zu verwandeln; wie er sie veranlasst, bald am Tage, bald des Nachts der Nahrung nachzugehen. Alle diese Verhältnisse sind für das Studium und die Bekämpfung der Schädlinge von grösster Bedeutung und lassen sich in ihrer Mannigfaltigkeit unter einen gemeinsamen physiologischen Gesichtspunkt bringen.

Der Kontaktreiz oder Stereotropismus ist bei den niedern Tieren weit verbreitet und das Verhalten und die Lebensweise vieler Arten lässt sich auf ihn zurückführen. Bei den tierischen Spermatozoen, denen er eigen ist, zeigt er sich, wie ich (4) und MASSART (19) nachwiesen, darin, dass sich jene festen Körpern dicht anzulegen oder in poröse Körper zu dringen das Bestreben haben. Ebenso verfahren die Regenwürmer, die Nematoden oder andere niedern Tiere und wählen dementsprechend ihren Aufenthalt. Auf dieser Erscheinung beruht unter anderm auch der Fang mit Gürteln, welche man den Obstbäumen gegen die Obstmade (*Carpocapsa pomonella*) anlegt; ebenso der Fang mittelst Brettchen oder platten Steinen, die man in den Gärten für Ohrwürmer oder andere niedere Tiere auslegt und die man dann einsammelt.

Nach A. SEITZ (21) kann man wahrnehmen, wie sich von den erwachsenen und in diesem Lebensalter zerstreut lebenden Raupen von *M. neustria* 2 bis 3 Exemplare mit ihren Längsaxen an einander legen, was unverkennbar die Wirkung des Kontaktreizes ist. Und dieser Fall führt uns vielleicht auch zu dem Socialismus der Insekten. Bekanntlich leben viele Raupen in der Jugend in gemeinsamen Nestern, was ihre Vernichtung durch Zerstörung des Nestes erleichtert. Andere Insekten, welche frei umherwandeln, wie die Heuschrecken, sind Herdentiere. Wenn sich aber mit zunehmendem Alter die Zustände im Innern des Organismus ändern, zerstreuen sich die Individuen vieler Arten und werden solitär. Unter bestimmten Einflüssen kann aber der Socialismus der Tiere wieder hergestellt werden, so bei der Ueberwinterung und Fortpflanzung.

Der Geotropismus, welcher als Reiz die Orientirung der Organismen gegen den Erdmittelpunkt veranlasst, mag sich wohl oft mit dem Phototropismus kombiniren und die Insekten zwingen, die Spitze der Aeste, die Krone der Bäume oder die niedern Regionen und das Erdreich aufzusuchen.

Der Rheotropismus, welcher von mir (5) an verschiedenen Tierklassen untersucht wurde und der sich besonders bei Wassertieren dokumentirt, besteht darin, dass sich das Tier gegen das strömende Medium, seltner in dessen Richtung einstellt, in dieser Stellung verharret oder sich vorwärts bewegt. Leicht kann man diese Erscheinung an Fischen in kleinen strömenden Gewässern oder an den auf der Wasseroberfläche laufenden Hydro-metriden wahrnehmen. Für die bewegte Luft ist der Rheotropismus nur noch wenig erforscht. WHEELER (24) bezeichnet ihn als Anemotropismus. Er giebt sich in diesem Falle in der Weise kund, dass die Insekten in der Luft gegen den Wind gewandt stehen. Die Rocky Mountain Heuschrecken (*Melanoplus sprutus*) fliegen bei schwachem Winde mit diesem; ist aber der Wind stärker, so wenden sie sich gegen ihn. Es ist ferner nicht unwahrscheinlich, dass der Rheotropismus manche Insektenarten veranlasst, ihre Nester oder Wohnungen in der Richtung der herrschenden Winde anzulegen. So erwähnt SCHMARDA (22), dass die Termiten in Australien kegelförmige Bauten in langen Reihen auführen, die in der Richtung der herrschenden Winde liegen.

Der Geruchssinn und die Anziehung durch riechende Stoffe spielt besonders in der Insektenwelt eine gewisse Rolle. J. PÉREZ und F. PLATEAU haben der Anziehung der Insekten durch die Blüten und ihre Gerüche eingehende Untersuchungen gewidmet. Seit einiger Zeit nun benutzt man diese Eigenschaft der Insekten, um sie zu vernichten, indem man sie durch besondere Flüssigkeiten ködert. Dabei scheint sich aber ein Umstand von praktischer Bedeutung geltend zu machen. Nach STANDFUSS (23) giebt gerade der Köderfang dem Lepidoptrologen am reichlichsten befruchtete, mit Eiern versehene Weibchen und damit in Uebereinstimmung wird von verschiedenen Seiten gemeldet, dass im Gegensatz zum Lichtfang der praktische Köderfang zahlreiche Weibchen liefert.

2. DER EINFLUSS ÄUSSERER UND INNERER FAKTOREN AUF DAS LEBEN UND DIE ENTWICKLUNG DER INSEKTEN.

Die Insektenwelt steht so sehr unter den Einflüssen klimatischer und atmosphärischer Verhältnisse, dass es nicht nötig ist, dieses besonders zu betonen. Demgegenüber sind unsere Kenntnisse von den physiologischen Vorgängen, die sich dabei im Organismus des Insekts abspielen, sehr gering. Von den vielen Beispielen, die hier in Frage kommen, seien nur einige erwähnt, da eine ausführliche Darstellung des Gegenstandes eine umfassende Arbeit verlangen würde.

Bezüglich der Wärme, welche in manchen Sommern vernichtend auf verschiedene Insekten wirkt, glaubt man im allgemeinen, dass die Eier und Larven vertrocknen, und bis zu einem gewissen Grade ist dieses wohl auch richtig. Aber auch die Wärme als solche vermag die plötzliche Abnahme der Schädlinge herbeizuführen. Vor mehrern Jahren untersuchte ich (10) unter Aufrechterhaltung der nötigen Feuchtigkeit den Einfluss von höhern Temperaturgraden auf Lepidopteren- und Dipterenlarven und kam dabei zu folgenden Schlüssen: "Die Temperaturgrade, welche hier in Frage kommen, sind ziemlich fest und, was besonders interessant ist, ziemlich niedrig. Gleichzeitig gehen in Folge der Einwirkung dieser Temperaturen im Organismus Veränderungen vor sich, die sich bei der Verfärbung des Blutes dokumentiren und bereits bei so niedrigen Temperaturen wie 40° und einer Expositionszeit von 15 Minuten beginnen. Ist bei $40-41^{\circ}$ die Expositionszeit eine lange, bis 40 Minuten, so können sich die Insektenlarven wieder vollständig erholen, ihre spätern Lebensschicksale werden aber ungewiss. Wir brauchen nicht weiter auf die Anwendung der hier gemachten Erfahrungen auf die freie Natur einzugehen. Eine derartige Wärme, wie wir sie in den vorliegenden Versuchen finden, kommt überall im Sommer im Freien vor. Ihre Einflüsse unterliegen hier in Folge lokaler Verhältnisse mannigfachen Abänderungen." Die Veränderungen im Blute bezogen sich auf die in ihm enthaltene Tyrosinase, eine Oxydase, die bei der Verfärbung und Verwandlung der Insekten eine rolle spielt, wie ich zu zeigen gesucht habe.¹

¹ Meine verschiedenen Veröffentlichungen über diesen Gegenstand finden sich zusammengestellt in No. 9.

Die Kälte ihrerseits kann auf die verschiedenen Insektenarten einen eigentümlichen Einfluss ausüben, mag es sich dabei um die Winterkälte oder um rauhe Klimate handeln. Das vollendete Insekt oder nur sein Weibchen kann nämlich flügellos werden. Dieser Apterismus ist uns u. a. von den Weibchen unserer Winterschmetterlinge (Geometriden) bekannt und diese Verhältnisse bilden die Basis für die alte Fangmethode der Klebgürtel, die man den Obstbäumen gegen die flügellosen Weibchen der *Ch. brumata* anlegt. Man kann die Atrophie der Flügel auch durch künstliche Kälte herbeiführen und die Bienenzüchter bemerken bisweilen, dass ihre Stöcke in Folge strenger Winterkälte flügellose Bienen geben. Ich (7, 12) habe mich spezieller mit dieser Erscheinung beschäftigt und bin dabei zu der Ansicht gelangt, dass die Kälte—und von der Wärme scheint dasselbe zu gelten—schädigend auf die Oxydase (Tyrosinase) wirkt, welche sich bei der Larve im ganzen Organismus vorfindet, sich aber bei der Puppe in den Flügeln konzentriert.

Grosse Feuchtigkeit kann auf den Insektenorganismus einen gleichfalls unerwarteten Einfluss ausüben. Von BATAILLON (1-3) und von mir (6) liegen Versuche vor, aus denen hervorgeht, dass in einer mit Feuchtigkeit gesättigten Atmosphäre das Spinnen der Larven unterdrückt wird. BATAILLON führt diese Verhältnisse darauf zurück, dass es für die Verwandlung nötig sei, dass der innere Druck vermindert wird und dass zu diesem Zwecke die Larven den Spinnstoff und den Darminhalt aus dem Körper entfernen. Eine mit Feuchtigkeit gesättigte Atmosphäre störe aber eine Ausscheidung. Gleichzeitig zeigte er an Seidenraupen, dass grössere Feuchtigkeit auch der Verwandlung hinderlich ist.

Auch über den Einfluss der Atmung (Sauerstoff) auf die Verwandlung haben BATAILLON (1-3) und ich (9) gearbeitet. Während der erstere die Ansicht vertritt, dass sich die Verwandlung der Larven in Folge einer durch Kohlensäureanhäufung veranlassten Erstickung der Larve vollzieht, habe ich zu zeigen versucht, dass oxydirende Enzyme bei der Verwandlung eine rolle spielen. Unter Luftabschluss oder in einer Blausäureatmosphäre gehaltene Larven verwandeln sich nicht oder geben unvollkommene, weichhäutige, ungefärbte Puppen. Der Einfluss

der Blausäure beruht aber auf der Verminderung der Oxydirbarkeit der Gewebe.

Bei Zucht von Insekten kann man oft bemerken, dass gewisse Arten zu bestimmten Tageszeiten aus dem Ei oder der Puppe auskommen, eine Erscheinung, die an das Oeffnen oder Schliessen der Blumen erinnert, welche man auf Spannungsverhältnisse in den Geweben zurückführt. Dieser Gegenstand bringt uns zu einem nicht minder interessanten, nämlich zu dem Einfluss der Jahreszeiten, der so bedeutend ist, dass man von einer Physiologie der Jahreszeiten sprechen kann. Vor allem sind in dieser Hinsicht der Herbst und der Nachsommer interessant. Eine Anzahl von Organismen vorfällt dann auf verschiedenen Entwicklungsstufen (Eier, Puppen, Sporen, Zwiebeln, Knospen) in einen Ruhezustand und keine Temperaturerhöhung vermag diese Ruhe zu unterbrechen, solange sie nicht abgelaufen ist. Oft aber schicken sich einige Individuen zu neuem Leben und zu neuer Entwicklung an und wir sehen dann einzelne Bäume zum zweiten Male blühen oder einzelne Schmetterlinge noch im Herbst fliegen. So giebt der gefürchtete Sauerwurm der Rebe (*C. ambiguella*) bisweilen noch in der Nachsaison eine sehr kleine Generation, was bei den Winzern die trügerische Hoffnung erweckt, das in den Unbillen des Herbstes die ganze Art der Vernichtung anheimfallen werde. Dem entsprechend ist es bisweilen gelungen, die Ruhe künstlich aufzuheben. Bekannt ist beispielshalber die Tatsache, dass im Sommer die Eier des Seidenspinners in einen solchen Ruhezustand verfallen, dessen Aufhebung durch Abkühlung der frischen Eier herbeigeführt werden kann. Den verschiedenen Mitteln, welche man bei Pflanzen und Tieren angewandt hat (Aether oder Chloroform, Kälte, Trockenheit usw.), liegt als gemeinsamer Faktor der Austritt von Wasser aus den Geweben zu Grunde. RAPH. DUBOIS (13) hat bereits seit lange gezeigt, dass die Kälte sowie die Anaesthetica eine solche Wirkung besitzen, die er unter dem Namen "Atmolyse" zusammenfasst.

Es ist von Interesse, dass der Herbst noch eine andere Erscheinung zeitigt. Im Herbst treten bei vielen Insekten und andern Arthropoden Männchen auf, so dass die ungeschlechtliche Fortpflanzung einer geschlechtlichen Platz macht. Aber auch die Pflanzen stehen unter dem Einfluss des Herbstes

und die sich in ihnen vollziehenden Veränderungen wirken ohne Zweifel ihrerseits auf die von ihnen lebenden, besonders auf die an ihnen saugenden Arten zurück. Der Pflanzenorganismus mit seinem Gehalt an Stärke, Zucker, Eiweiss und mit seinen Enzymen ist im Winter, Sommer, oder Herbst ein anderer und es ist nicht denkbar, dass diese Wandlungen ohne nachhaltige Wirkung auf die Entwicklung der an den Pflanzenorganen saugenden oder fressenden Parasiten bleiben.

Ich habe soeben der Entstehung der Männchen gedacht und mit diesem Gegenstande kennzeichnen wir ein Gebiet, welches die angewandte Entomologie im hohen Grade interessirt. Ich meine die Ursache der Entstehung der Geschlechter, jene Frage, welche zur Zeit im Vordergrund biologischer Forschung steht. Es geht hieraus klar hervor, wie sehr physiologische und angewandte Wissenschaft Hand in Hand gehen. Beide laufen im Grunde auf die Kardinalfragen des Lebens hinaus.

3. DIE PHYSIOLOGISCHE WIRKUNG DER INSEKTIZIDEN.

Ein Gegenstand, über den wir noch sehr wenig wissen, sind die physiologischen Vorgänge, welche sich im Körper der Insekten unter dem Einfluss der Insektiziden abspielen; denn bisher hat man sich mit dieser Frage wenig beschäftigt. Die Pharmakologie als Teil der Schädlingsforschung existirt noch nicht. Man begnügt sich meist mit unbestimmten Definitionen wie "Magen"- oder "Kontakt"-Gift usw. Wohl wenige von den Personen, welche Blausäure als Räuchermittel angewandt, werden daher wohl gewusst haben, welches die physiologische Wirkung der Blausäure ist. Nach den Untersuchungen von GEPPERT (16) besteht sie darin, dass die Gewebe ihre Fähigkeit, Sauerstoff aufzunehmen, verlieren und dass der Tod durch Ersticken bei Gegenwart von Luftsauerstoff erfolgt. Seit 12 Jahren beschäftigt mich dieser Gegenstand und bereits auf dem Internat. Kongress in Paris (1900), Abt. Pflanzenpathologie sprach ich (9) von dem Einfluss der Blausäure auf das Leben der Raupen.

Mit den Kontaktflüssigkeiten hat man sich gleichfalls abgefunden, indem man sich kaum die Frage nach dem Wesen ihrer Wirkung vorlegt. Man begnügt sich meist mit der

Aussage, dass sie in die Tracheen dringen und den Tod des Insekts durch Ersticken herbeiführen. Durch diese Annahme lässt sich aber der schnelle Tod des Tieres wohl kaum erklären und ausserdem gelangen die Kontaktpulver wohl nur in sehr beschränkter Masse in die Tracheen. Ich (11) bin geneigt zu glauben, dass die Kontaktmittel auf die Endorgane der Tast oder Sinnesorgane einwirken. Damit stimmt auch die Angabe von FUJITANI (14) überein, nach welcher der wirksame Bestandteil des Pyrethrums ein Nerven-Muskelgift ist, gegen das Fische und Insekten sehr empfindlich sind.

Zum Schlusse sei darauf aufmerksam gemacht, dass es noch etwas verfrüht sein würde, von dem Einfluss der saugenden Insekten auf die Pflanzenorgane zu sprechen, etwa im Sinne der enzymatischen Einwirkung der Pilze auf die Pflanzenorgane, wenn schon über diesen Gegenstand einige wenige Beobachtungen vorliegen. Dass aber eine direkte chemische Wirkung des saugenden Insekts auf die Pflanzen besteht, wird man bei dem heutigen Stand unserer Kenntnis von den Enzymen und Toxinen wohl kaum in Abrede stellen können. Denn man vermag nicht einzusehen, weshalb der Stich einer Blattlaus, der ein Pflanzenorgan umbildet, nicht ebenso gut toxische Substanzen in die Gewebe bringt wie der Stich eines Skorpions, einer Biene oder der Biss einer Schlange.

In den voraufgehenden Ausführungen habe ich versucht, an einigen Gegenständen von allgemeinem Interesse, mit denen ich mich selbst beschäftigt habe, zu zeigen, welche Bedeutung die physiologische Forschung für die sich entwickelnde Schädlingswissenschaft besitzt, wie sie uns in den Kern vieler Fragen führt und wie ihr daher ein hervorragender Platz auf diesem Gebiet der Wissenschaft gebührt.

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LE MÉLANISME CHEZ DIVERS CRYPTOCEPHALUS PALÉARCTIQUES.

Par MAURICE PIC, DIGOIN.

ON peut observer chez les *Cryptocephalus* Müll. paléarctiques deux sortes de mélanisme : 1^e, le mélanisme des espèces dont la coloration normale est verte, ou bleue, métallique ; 2^e, le mélanisme des espèces ayant des macules, ou fascies, élytrales.

Nous constatons le premier de ces mélanismes chez les *tibialis* Bris. (var. *Fauconneti* Pic), *violaceus* Laich. (var. *helveticus* Pic), *Schaefferi* Schrank ♂ (var. *sabaudus* Pic), chez certaines espèces communes du groupe de *cristula* Dufour, et l'on peut dire qu'il existe, ou peut se rencontrer, chez toutes les espèces de coloration analogue à celles que je viens de citer.

La couleur violacée, ou bleue foncée, chez ces espèces fait fréquemment le passage entre la coloration normale et la variété, ou aberration, noire.

Quant à la seconde production du mélanisme nous pouvons la constater chez *rugicollis* Ol. (var. *subverrucosus* Pic), *albo-lineatus* Suffr. (var. *Bischoffi* Tappes, qui paraît fort rare), *lusitanicus* Suffr. (var. *inapicalis* Pic), 4-*pustulatus* Gylh. (var. *aethiops* Weise), 4-*guttatus* Germ. (var. *maurus* Suffr.), *flavipes* F. (var. *signatifrons* Suffr. et *obscuripes* Weise), 10-*maculatus* L. (var. *bothnicus* L. et voisines), *bipunctatus* L. (var. *clericus* Seidl.).

Par contre c'est la forme type qui offre une coloration élytrale foncée chez *frenatus* Laich.,¹ tandis que les variétés sont foncées, tachées de clair, ou testacées et variablement maculées de foncé.

Chez certaines espèces l'agrandissement très grand, ou la jonction des fascies, ou macules, noires sur les élytres produisent un demi-mélanisme, le sommet ou le pourtour des élytres restant testacé, ou jaune, alors que tout le reste de ces organes est foncé. Nous devons ranger dans ce demi-mélanisme les variétés suivantes : var. *verrucosus* Suffr. de *rugicollis* Ol., var. *rufolim-*

¹ Chez *crassus* Ol. la forme type a les élytres noirs avec une seule macule marginale qui arrive à s'oblitérer.

batus Suffr. de *primarius* Har. (variété qui paraît fort rare), var. *albarinus* Pic et *noctifer* Pic de *lusitanicus* Suffr., var. *ussuriensis* Weise de *Mannerheimi* Gebl., var. *Thomsoni* Weise de *bipunctatus* L., var. *sublimbellus* Pic de *limbellus* Suffr., var. *ramosus* Suffr. de *Stschuckini* Fald., var. *hirtifrons* Graels. et voisines de *6-pustulatus* Villers et var. *Schrammi* Pic de *vittatus* F.

Dans le groupe des petites espèces, celles que de MARSEUL a groupées sous le qualificatif de Nains, les variétés *moestus* Weise (de *bilineatus* L.), *jucundus* Fald. (de *elegantulus* Grav.), *lugubris* Dem. (de *pygmæus* F.), *Marshami* Weise (de *pusillus* F.), *vitticollis* Weise (de *rufipes* Goeze), *Brondeli* Pic et *paulonotatus* Pic (de *discicollis* Fairm.), tournent au mélanisme, au moins au mélanisme élytral, plus ou moins complet.

Certaines des variétés de la 2^e catégorie, présentant un système de coloration parfaitement identique, risqueraient de se confondre. Telles sont les var. *æthiops* Weise et *maurus* Weise ; la 2^e présente une forme plus robuste que la première. La variété *Thomsoni* Weise, de *bipustulatus* L., est très facile à confondre avec l'espèce *biguttatus* Scop. ; on la reconnaîtra à sa macule claire apicale plus étroite, ou moins large.

Certaines variétés atteintes de mélanisme sont si différentes de la forme typique qu'il faut un œil très exercé pour les déterminer et les classer à leur place exacte : parmi celles-ci je puis citer la var. *Schrammi* Pic, de *vittatus* F., qui est entièrement noire sauf une macule humérale externe jaune ; cette macule la distingue de la var. *maurus* Suffr., de *4-guttatus* Germ., qui lui ressemble beaucoup.

Je termine cet article en donnant une étude dichotomique qui facilitera la distinction des espèces et variétés de nos régions qui me sont connues, dont les élytres sont entièrement noirs (correspondant à ma 2^e catégorie) et qui ne font pas partie du groupe des Nains.

1. Dessus du corps glabre ; ponctuation du prothorax variée, d'ordinaire subarrondie, écartée, parfois presque nulle. . . . (2)

1'. Dessus du corps pubescent ; ponctuation du prothorax plus ou moins strigieuse ou allongée. Sicile. *C. rugicollis* var. *subverrucosus* Pic.

2. Écusson noir. (3)

2'. Écusson plus ou moins taché de jaune. (Cette variété a parfois le repli huméral roux.) Espagne. *C. lusitanicus* var. *inapicalis* Pic.

3. Prothorax entièrement noir, au moins chez ♀, parfois avec un étroit rebord flave mais alors sans lignes discales claires. (6)

3'. Prothorax plus ou moins et variablement marqué de testacé sur le disque, cette coloration formant une ou plusieurs bandes longitudinales complètes, ou raccourcies. Repli huméral parfois jaune ou roux. (4)

4. Plus allongé; stries des élytres plus faibles et moins fortement ponctuées; bande médiane claire du prothorax plus ou moins large et subparallèle, côtés d'ordinaire largement bordés de testacé. Europe-Centrale. *C. frenatus* Laich.

4'. Assez large; stries des élytres plus régulières et fortement ponctuées; bande claire médiane du prothorax moins large, parfois divisée postérieurement, ou plus courte; côtés entièrement foncés, ou presque. Europe. *C. 10-maculatus* L. (var. diverses).¹

5. Tête plus ou moins maculée de jaune sur le front ou testacée tout au moins antérieurement; 4 pattes antérieures, ou les antérieures au moins, en partie testacées. (6)

5'. Tête et pattes entièrement noires. Croatie, Hongrie, Russie. *C. 4-guttatus* var. *maurus* Suffr.²

6. Ponctuation élytrale plus ou moins écartée; front avec une tache testacée variable. (7)

6'. Ponctuation élytrale rapprochée, au moins près de la suture; front sans tache testacée. Alpes. *C. 4-pustulatus* var. *æthiops* Weise.

7. Quatre pattes antérieures plus ou moins testacées. Tyrol, Allemagne, Suisse, Italie, France Mérid., etc. *C. flavipes* var. *signatifrons* Suffr.

7'. Pattes presque entièrement noires. Allemagne, Suisse, etc. *C. flavipes* var. *obscuripes* Weise.

¹ Je ne connais pas en nature la var. *bardanæ* L., qui a le prothorax entièrement noir.

² La var. *clericus* Seidl. de *bipunctatus* L. m'est inconnue; sans doute var. *maurus* s'en distingue par la ponctuation assez forte et sans ordre de ses élytres.

ÜBER EINIGE BEZIEHUNGEN ZWISCHEN PALAEON- TOLOGIE, GEOGRAPHISCHER VERBREITUNG UND PHYLOGENIE DER INSEKTEN.

Von ANTON HANDLIRSCH, WIEN.

(Tafel XI, XII, XIII.)

WENN ich mir erlaube, hier im Vaterlande eines WALLACE von tiergeographischen Problemen zu sprechen, so geschieht es sicher nicht in der Absicht, die allgemein geschätzten grundlegenden Theorien dieses grossen Forschers zu bekämpfen oder wesentlich zu ergänzen, denn, was ich dem Kongresse in aller Kürze vorlegen will, ist nichts anderes als ein Nebenprodukt meiner paläontologisch-phylogenetischen Untersuchungen.

Schon vor längerer Zeit habe ich die Aufmerksamkeit meiner Kollegen auf die Tatsache zu lenken gesucht, dass die sogenannten "Holometabolen," d. h. jene Insektengruppen, bei welchen die Flügel erst in einem dem geschlechtsreifen Stadium unmittelbar vorangehenden ruhenden Puppen- oder Nymphenstadium in Erscheinung treten, im Gegensatze zu den "Heterometabolen," bei welchen kein solches Ruhestadium in der Metamorphose auftritt und bei denen die Flugorgane schon frühzeitig bei den Larven äusserlich sichtbar sind, im allgemeinen weniger ausgesprochen thermophil sind. Diese Erscheinung schien mir in einem gewissen Zusammenhange mit der Tatsache zu stehen, dass zuerst im Palaeozoikum nur heterometabole Insekten auftreten, während holometabole Formen erst nach der permischen Eiszeit zu finden sind. Der Gedanke, die offenbar in mehreren Entwicklungsreihen gleichzeitig zur Ausbildung gelangte Holometabolie einem klimatischen Faktor zuzuschreiben, lag nahe und eine Diskussion der ganzen Frage schien umso mehr erwünscht, als wir ja über die wahren Ursachen der meisten bedeutenden Schritte, welche die Evolution der

Tiere im Laufe der Zeiten gemacht hat, noch völlig im Unklaren sind.

Dem scheinbar unbedeutenden Schritte von der Heterometabolie zur Holometabolie verdankt vielleicht eine halbe Million der heute lebenden Species ihre Existenz und es kann darum für die allgemeine Biologie nicht ohne Bedeutung sein, zu wissen, ob es sich hier um eine direkte Bewirkung, um eine selektive Anpassung oder um einen rein orthogenetischen Entwicklungsvorgang handelt. Darum komme ich hier noch einmal auf den Gegenstand zurück und werde so lange immer wieder darauf zurückkommen, bis sich ernste Biologen dazu bequemen, die Frage aufzugreifen und sie nicht, wie es bisher der Fall war, mit einigen belanglosen Worten abzutun.

Betrachten wir eine Reihe von Insektenfamilien in Bezug auf die zahlenmässige Verteilung ihrer Arten auf verschiedene Klimazonen, so finden wir ausserordentliche Verschiedenheiten, aber es zeigt sich auf den ersten Blick noch keinerlei Gesetzmässigkeit: Wir sehen nur, dass einzelne Insektengruppen über alle Klimazonen fast gleichmässig verteilt sind, während andere in den kälteren und gemässigten, wieder andere in den heissen Ländern mehr oder minder stark überwiegen. Man wird sagen, diese Tatsache sei schon längst bekannt.

Versuchen wir nun, die betreffenden Gruppen in phylogenetischer Reihenfolge anzuordnen, so dass wir bei jeder Entwicklungsreihe zuerst die ursprünglichen und älteren und dann in aufsteigender Folge die höher spezialisierten Gruppen anführen, wie in nachstehenden Tabellen, so wird sich bald zeigen, dass doch eine gewisse Gesetzmässigkeit zu herrschen scheint. Und ich bin überzeugt, dass diese Gesetzmässigkeit viel deutlicher in Erscheinung treten wird, sobald unsere systematischen Detailbearbeitungen so weit gediehen sein werden, dass man die Klimazonen schärfer abgrenzen kann, als es mir momenten möglich ist, denn die Angaben über Verbreitung sind bei den meisten Arten noch recht ungenau. Ich muss z. B. eine Art, welche aus "Italien" angegehen wird, zur wärmeren Zone rechnen, auch wenn sie vielleicht nur auf der Höhe des Appenin vorkommt, ebenso eine mit "Nordamerika" bezeichnete zur kälteren Zone, selbst wenn sie vielleicht nur in Florida lebt usw. Wohl gleichen sich diese Fehler

durch die Berücksichtigung der grossen Masse von Formen einigermaßen aus, aber Fehlerquellen sind es immerhin; glücklicherweise meist solche, welche die Zahlen zu Ungunsten meiner Theorie beeinflussen.

TABELLE I.

	I.	II.	III.		I.	II.	III.
Locustoid. s. l. .	546	890	3714	Galgul. + Pelogon.	4	5	49
Dermaptera . .	45	144	686	Naucoridæ . .	7	13	112
Phasmoidea . .	53	78	1882	Belostomidæ . .	14	14	76
Acridioidea . .	846	996	2811	Nepidæ . .	5	25	98
Thysanoptera . .	273	69	110	Notonectidæ. .	17	24	78
Blattoid. + Mantid.	145	531	2572	Corixidæ . .	97	63	70
Isoptera . .	16	45	422	Reduviidæ . .	110	498	2254
Psocidæ s. l. .	166	112	318	Pyrrhocoridæ . .	22	32	360
Mallophaga . .	767	236	727	Coreidæ . .	186	364	1486
Pediculidæ . .	92	63	83	Pentatomidæ . .	460	1100	3675
Embioidea . .	3	23	48	Lygæidæ . .	351	709	1071
Lepismoidea . .	25	84	99	Berytidæ . .	27	31	23
Machiloidea . .	17	37	20	Cimicidæ . .	16	8	16
Collembola . .	761	175	131	Rican. Flatid. etc.	73	152	1209
Odonata . .	508	413	2096	Cicadidæ . .	55	226	892
Ephemeridæ . .	291	112	122	Coccidæ . .	904	476	1266
Perlaria . .	320	97	92	Aleurodidæ . .	95	8	77

In dieser und den folgenden Tabellen bezeichnet die Zahlenkolonne I. das kalte und kältere gemässigte Gebiet, also etwa das arktische Europa, Asien, und Nordamerika, Sibirien, Mitteleuropa mit Einschluss der Alpen, das Gebiet der Vereinigten Staaten und Canada, Chile-Patagonien und Neuseeland. Die Kolonne II. enthält dagegen das ganze Mediterrangebiet mit Vorderasien und Nordafrika, ferner China, Japan, und Südafrika, während in Kolonne III. das gesammte tropische Central- und Südamerika, Vorder- und Hinterindien mit Ceylon und dem Malayischen Gebiete, Papuasien, Oceanien, Ost- u.

Westafrika, Madagaskar und Australien zusammengefasst werden musste. Ich behalte mir vor, die umfangreichen genaueren Tabellen, welcher dieser kurzen Übersicht zugrunde liegen, an anderer Stelle zu veröffentlichen, denn hier handelt es sich in erster Linie darum, einen, wie ich glaube, neuen, schon jetzt gangbaren Weg der exakten Biologie anzudeuten. Aus diesem Grunde wurden auch bei weitem nicht alle untersuchten Familien aufgenommen, sondern nur eine Reihe von Beispielen.

Obige Tabelle enthält die wichtigsten Gruppen der heterometabolen Insekten. Die erste Entwicklungsreihe, die Orthoptera im engeren Sinne, die schon im Carbon mit Locustiden-ähnlichen Formen beginnt, zu denen im Jura Phasmiden und im Tertiär die Dermapteren, Acridier und Physopoden hinzutreten, zeigt überall ein starkes Dominieren der thermophilen Formen. Die Acridier erscheinen bereits deutlich stärker in den kälteren Gebieten vertreten als z. B. die Locustiden (und Grylliden) oder als die Phasmiden und bei den höchstspezialisierten Physopoden oder Thysanopteren dominieren, wenigstens nach dem gegenwärtigen Stande unseres Wissens, die Formen der kälteren Gebiete.

Ebenso deutlich zeigt sich in der 2. Reihe, welche mit den gleichfalls carbonischen Blattiden beginnt, eine deutliche Abnahme der Thermophilie in aufsteigender Entwicklungsrichtung, eine Erscheinung, die sich mindestens nicht einfach aus der geringeren Erforschung der Tropenländer erklären lässt.

Ausgesprochen thermophil ist die isolierte Reliktgruppe der Embioiden. Von den Apterygogenen erweisen sich die primitiven Lepismoiden ausgesprochen thermophil; die hochspezialisierten Collembolen dagegen verhalten sich gerade umgekehrt.

Die tiefstehenden cryptoceraten Hemipteren, die Galguliden u. Pelogoniden sind ausgesprochen thermophil, ebenso wie die Naucoriden, Belostomiden, Nepiden, und Notonectiden, während die höchstspezialisierten Formen dieser Reihe, die Corixiden, bereits in den kälteren Gebieten zu dominieren beginnen. Von den angeführten Beispielen der Gymnoceraten oder Landwanzen zeigen sich nur die hochspezialisierten Berytiden und Cimiciden (= Clinocoriden) indifferent, während alle anderen ausgesprochen thermophil sind, ebenso wie die tiefstehenden

Homopteren, die Fulgoriden, Cicadiden (gleiches gilt für Cercopiden, Jassiden, etc.). Bei hochspezialisierten Homopteren wie Cocciden, Aleurodiden (und Aphididen) beginnt sich auch hier das Verhältniss umzukehren.

So wie die meist in ruhigen Wässern lebenden Wasserwanzen sich in Bezug auf Thermophilie kaum von den landbewohn-

TABELLE II.

	I.	II.	III.		I.	II.	III.
Silphidæ . . .	699	495	120	Sisyridæ . . .	8	2	4
Scydmaenidæ . .	352	377	400	Hemerobiidæ . .	123	29	69
Staphylinidæ p.p.	1869	1322	2885	Chrysopidæ . . .	107	96	171
Pselaphidæ . . .	702	843	1898	Myrmeleonidæ . .	102	166	271
Melandryidæ . .	188	87	84	Ascalaphidæ . . .	14	64	151
Edemeridæ . . .	166	220	259	Lydidæ, Cephid. . .	179	119	1
Meloidæ	341	756	756	Tenthredinidæ . .	1964	752	817
Tenebrionidæ . .	1533	4349	4979	Ichneum. Bracon. Chalcid., etc.	17011	2953	6644
Donaciinæ	89	52	14	Cynipidæ	1181	333	182
Clythrinæ	88	414	472	Evaniidæ	168	147	502
Hispinæ	48	97	1539	Stephan. Pelecin. .	10	8	106
Aphodiinæ	393	584	538	Sapygidæ	34	14	5
Coprinæ p.p. . . .	61	414	1271	Scoliidæ	148	274	592
Sialidæ	10	7	1	Mutillidæ	380	493	1516
Chauliodidæ . . .	11	11	11	Formicidæ	458	597	2888
Corydalidæ	6	5	37	Sphegidæ	1489	1461	2243
Raphidiidæ	29	26	—	Vespidæ	468	591	1763

enden Formen unterscheiden, so kann man auch bei den vorwiegend in stehendem Wasser sich entwickelnden alten Odonaten eine ausgesprochene Thermophilie nachweisen und nur die beiden alten heterometabolen amphibiotischen Gruppen der Ephemeriden und Perliden scheinen eine Ausnahmestellung einzunehmen, die sich vielleicht daraus erklären lässt, dass diese Formen meist in raschfließenden Wässern leben, deren

Temperatur ja auch im Winter sehr oft nicht unter einen gewissen Durchschnitt sinkt.

Wir können also ganz im allgemeinen sagen, dass die Heterometabolen ursprünglich ausgesprochen thermophil sind und dass nur bei hochspezialisierten Endgliedern eine Zunahme kälteliebender Formen eintritt.

TABELLE III.

	I.	II.	III.		I.	II.	III.
Panorpidæ . .	41	63	25	Blepharoceridæ . .	13	5	5
Bittacidæ . .	11	6	13	Psychodidæ . .	116	26	43
Trichoptera . .	1090	390	340	Chironomidæ . .	673	84	272
Micropteryg. Erioccephalidæ . .	55	28	1	Culicidæ . .	218	126	946
Gracilariidæ . .	346	92	218	Tipulidæ . .	1159	289	488
Adelidæ . .	67	107	44	Xylophagidæ . .	31	7	20
Pterophoridæ . .	167	162	189	Stratiomyidæ . .	346	223	643
Hepialidæ . .	64	27	123	Leptidæ . .	186	70	86
Brephidæ . .	10	4	—	Tabanidæ . .	447	369	1097
Sphingidæ . .	139	195	976	Therevidæ . .	143	78	92
Syntomidæ . .	32	93	1978	Bombyliidæ . .	522	856	684
Hesperiidæ . .	165	246	2167	Asilidæ . .	598	937	1534
Mycetophilidæ . .	1535	110	312	Empidæ . .	1381	393	243
Cecidomyidæ . .	1910	190	191	Dolichopodidæ . .	998	305	425
Bibionidæ . .	209	59	89	Lonchopt. Platypez. . .	63	14	5
Rhyphidæ . .	16	3	12	Pipunculidæ . .	85	55	66
Ptychopt. Dixidæ . .	39	9	2	Syrphidæ . .	1042	650	1097

Vergleichen wir nun die holometabolen Insektengruppen der folgenden Tabellen:

Unter den Entwicklungsreihen der Coleopteren zeichnet sich gleich jene der Silphiden-Staphyliniden besonders aus. Wir sehen, dass die relativ ursprüngliche Familie der Silphiden in den kälteren u. gemäßigten Gebieten ungleich stärker vertreten ist als in den Tropen, während die höher spezialisierten Elemente, namentlich die Pselaphiden, sich gerade umgekehrt verhalten,

was doch gewiss nicht auf den verschiedenen Stand der Kenntniss zurückzuführen ist.

In der Heteromerenreihe finden wir ein ähnliches Verhältniss zwischen den ursprünglichen Melandryiden und den hochspezialisierten Meloiden oder Tenebrioniden; unter den Chrysomeliden zwischen den Donaciinen und Hispinen. Die tieferstehenden Aphodiinen sind minder thermophil als die höherstehenden Coprinen und ähnlich verhält es sich bei vielen anderen Coleopterengruppen (z. B. Carabiden, Canthariden, u. a.).

Unter den Megalopteren sind die einfachen Sialiden fast nur in den kälteren Gebieten vertreten, die Chauliodiden überall gleich und die hochspezialisierten Corydaliden ausgesprochen thermophil. Die alten Raphidien fehlen in den Tropen.

Unter den echten Neuropteren sind die ursprünglichen Sisyriden und Hemerobiiden schwach thermophil, die viel höherstehenden Myrmeleoniden und besonders Ascalaphiden, ebenso wie die Psychopsiden u. Nemopteriden ausgesprochen thermophil.

Die primitivste unter den lebenden Hymenopterenfamilien, die Lydiden (+ Cephiden) verhält sich in den Kolonnen I. u. III. wie 179 zu 1! Auch die meisten anderen nicht aculeaten Gruppen überwiegen noch stark in den kälteren Gebieten, wieder mit Ausnahme einiger hochspezialisierter Elemente, wie Evaniidæ, Stephanidæ, Pelecinidæ etc., bei denen sich das Verhältniss umkehrt. Unter den Aculeaten sind die in den Tropen schwach vertretenen Sapygiden gewiss noch sehr ursprüngliche Elemente; von da aus nimmt die Thermophilie über Scoliiden und Mutilliden zu den Formiciden immer zu.

Die gewiss primitiveren Panorpiden sind ausgesprochen weniger thermophil als die abgeleiteten Bittaciden. Die Trichopteren überwiegen entschieden in den kälteren Gebieten.

Unter den Lepidopteren verhalten sich bei der primitivsten Gruppe der Micropterygiden u. Eriocephaliden die kälteliebenden Arten zu den tropischen wie 55 zu 1! Auch bei anderen sicher alten Gruppen wie Gracilariiden, Adeliden, Brephiden überwiegen noch die Formen der kälteren Gebiete, während im Gegensatz dazu bei unzweifelhaft hochspezialisierten Gliedern, wie Sphingiden, Syntomiden, Hesperiididen u. vielen anderen, tropische Formen weitaus vorherrschen.

Noch schärfer treten diese Verhältnisse in den verschiedenen Reihen der Dipteren hervor: Unter den eucephalen nematoceren Orthorrhaphen sind alle angeführten Gruppen mit Ausnahme der Culiciden ausgesprochen stärker in den kälteren Gebieten vertreten, ebenso die Tipuliden. Gleiches gilt für die ursprünglichsten Gruppen der orthorrhaphen Brachyceren; Xylophagiden, Leptiden, Thereviden, Empiden, Dolichopodiden und für die Lonchopteriden und Platypeziden unter den Cyclorrhaphen. Dagegen dominieren die abgeleiteten Gruppen Stratiomyidæ, Tabanidæ, Bombyliidæ, Asilidæ, Syrphidæ, und viele andere in den warmen Ländern.

Es ergibt sich aus diesen Betrachtungen, dass sich die Holometabolen gerade umgekehrt verhalten wie die Heterometabolen, indem bei ihnen die Thermophilie mit der höheren Spezialisierung zunimmt und bei den primitiven Formen kaum ausgebildet ist.

Ziehen wir die Schlüsse aus diesen Tatsachen, so wird es kaum möglich sein, die vollkommene Metamorphose einfach als eine direkte oder selektive Anpassung an Kälte zu deuten, denn auch von den Holometabolen lebt einerseits die überwiegende Menge in heissen Ländern und noch dazu gerade jene Elemente, bei denen die Holometabolie den höchsten Grad erreicht hat, und anderseits sehen wir ja, dass auch Heterometabole in kälteren Gegenden leben können. Die Holometabolie ist, ganz allgemein gesprochen, eine Abkürzung der Ernährungsperiode, verbunden mit einem Hinausschieben der Entwicklung definitiver Organe (in erster Linie der Flügel) in ein späteres ruhendes Entwicklungsstadium. Die Frassperiode könnte nicht nur durch frostreichen Winter, sondern auch durch trockene Jahreszeiten in ständig heissen Ländern abgekürzt worden sein und würde die Holometabolie, die, wie wir gesehen haben, doch sicher in einer gewissen Beziehung zur Kälte steht, auch darum nicht restlos erklären, weil ja die ersten Holometabolen, wie z. B. Panorpiden, tiefstehende Coleopteren, Neuropteren, Megalopteren, Raphidien jedenfalls, so wie ihre Vorfahren, noch keine Pflanzenfresser waren. Zudem erscheint mir die Vorstellung schwierig, dass sich einst eine Larve durch Hinausschieben eines Teiles der Organentwicklung Verhältnissen anpasste, welche ja erst später eintraten und von denen sie daher keine Ahnung haben konnte. Ferner wäre noch zu

bedenken, dass kurze Ernährungsperioden auch bei sehr vielen Heterometabolen vorkommen, ja sogar mehrere Generationen in einer Saison und dass endlich auch bei so manchen Holometabolen (allerdings wahrscheinlich sekundär) mehrere Jahre zur Larvenentwicklung nötig sind.

Die ursprünglichsten holometabolen Larven waren zweifelsohne der Imago ziemlich ähnlich, bis auf das Fehlen der Flügel, und alle stark reduzierten oder modifizierten Larventypen sind erst entstanden, als die Holometabolie bereits fertig war. Wir brauchen also nur eine Erklärung für das Hinausschieben der Flügelentwicklung und diese stelle ich mir etwa so vor:

Kälte hat offenbar in einer bestimmten "kritischen" Periode der individuellen Entwicklung retardierend auf die Ausbildung der Flügelanlagen gewirkt, welche dann später sehr rasch mit histolytischen Prozessen vor sich ging. Diese histolytischen Prozesse dürften das Ruhestadium bedingt haben. Die "kritische" Periode dürfte entweder in das früheste Embryonalleben fallen oder noch wahrscheinlicher schon in die Zeit der Anlage der Eizellen, also in das vorgeschlechtsreife Stadium. Letzteres erscheint mir auch deshalb zutreffend, weil die meisten Holometabolen und speziell die ursprünglicheren Formen als Larven oder Puppen überwintern. Vielleicht erklärt sich durch diese Annahme auch, warum nur ganz bestimmte, aber sicher mehrere verschiedene heterometabole Formen holometabol wurden. Dass weiterhin die durch viele Generationen sich wiederholende retardierende Einwirkung der Kälte schliesslich zu einer Stabilisierung der neuen Entwicklungsart führen konnte, zu einer Erblichkeit und Beibehaltung derselben eventuell auch nach dem Aufhören der ursprünglichen Ursache und sogar zu einer orthogenetischen Weiterentwicklung, kann wohl umsoweniger befremden, als ja in der Holometabolie gewiss der Schlüssel zur weiteren Ausbildung der allerverschiedensten Lebens- und Ernährungsweisen der Larven lag, wodurch wieder die Grundbedingungen für die Entstehung der parallel in verschiedenen Reihen auftretenden bekannten caenogenetischen Larventypen gegeben waren.

Hier wäre, glaube ich, ein dankbares Thema für die Experimentalzoologie: Man versuche, ob es möglich ist, die Ausbildung der Flügel und anderer Organe der Jungen von verschiedenen

Heterometabolen durch Einwirkung von Kälte in ganz bestimmten Entwicklungsstadien der Eltern zu beeinflussen. Man wähle dazu nicht Heterometabole, welche bereits hochspezialisiert und aus irgend welchen Gründen befähigt sind, in kälteren Gegenden zu leben, sondern thermophile, regelmässig geflügelte und möglichst ursprüngliche Arten aus verschiedenen Gruppen.

Wie obige Ausführungen gezeigt haben, bestehen bei den Insekten zweifellos enge Beziehungen zwischen der Verbreitung auf die verschiedenen Klimazonen und dem Alter bzw. der Entwicklungshöhe der betreffenden Gruppe und wohl niemand wird daran zweifeln, dass die räumliche Verteilung dieser Tierformen auch in engen Beziehungen zu allen jenen Faktoren steht, welche wir als ökologische zusammenzufassen pflegen: Ein Waldtier kann nur dort leben, wo Wald ist, ein Sandtier, nur wo sich Sand findet, u. dgl. Jedoch nicht überall, wo Wald und wo Sand ist, leben die *gleichen* Wald- und Sandbewohner, nicht überall, wo gleiche ökologische Bedingungen herrschen, ist eine spezifisch oder generisch identische Fauna und der Probleme für tiergeographische Arbeiten, welche uns die Übereinstimmungen und die Verschiedenheiten der einzelnen Faunen erklären wollen, gibt es in Hülle und Fülle. Scharfe Gegensätze in der Betrachtungsweise und Methode treten zu Tage und ursprünglich ganz getrennte Disziplinen wie Geologie und Palaeogeographie treten in Wechselwirkung mit der ursprünglichen Tiergeographie. Einer palaeogeographischen oder geologischen Hypothese zuliebe wird oft den zoologischen Tatsachen Gewalt angetan.

Es ist bekannt, dass in der Tiergeographie heute zwei Richtungen einander mehr oder minder schroff gegenüberstehen, von denen die ältere, durch A. R. WALLACE begründete an eine relativ weitgehende Konstanz in der Verteilung von Land und Wasser auf unserer Erde glaubt und diese Ansicht hauptsächlich auf statistischen Wege zu begründen sucht, während die andere jüngere Richtung nach der von H. v. IHERING propagierten sogenannten analytischen Methode arbeitet und, je nach Bedarf, hypothetische Länder und Ozeane konstruiert, um die oft recht merkwürdig erscheinenden Beziehungen oder Unterschiede zwischen heute getrennten oder verbundenen

Faunengebieten zu erklären. Während nach WALLACE die Océane und Kontinente während der Tertiärzeit nicht wesentlich von dem heutigen Zustande verschieden waren, konstruiert IHERING eine tertiäre Welt von einem fremdartigen Aussehen, wie es aus beigefügter Skizze ersichtlich ist (Taf. XI, Karte I).

Gegen die streng analytische Methode, welche zu einem solchen Resultate führte, wäre an und für sich kaum ein ernster Einwand zu erheben, denn sie stützt sich mit Vorliebe auf die palaeontologische Überlieferung. Untersuchen wir aber genau, so finden wir bald, dass es vorwiegend negative Ergebnisse der Palaeontologie sind, aus welchen Schlüsse gezogen werden, denn die positiven palaeontologischen Daten sind trotz der enormen Fortschritte, welche diese Wissenschaft im Laufe der letzten Dezennien gemacht hat, wenigstens in Bezug auf sehr viele Tiergruppen noch recht kümmerlich. Umso gewissenhafter müssen wir daher alles berücksichtigen, was bisher dem Schosse der Erde entrissen wurde, denn es zeigt uns bereits in vielen Fällen, wie verschieden die Verbreitung so mancher Gruppe in früheren Perioden im Vergleiche zur Gegenwart war:

Wie anders würden wir über eine Gruppe denken, welche heute durch 12 Genera mit 52 Species ausschliesslich in Australien, Neuseeland, Südamerika und am Cap vertreten ist, wenn wir nicht wüssten, dass mindestens eine sehr ursprüngliche Form derselben Gruppe im Oligocän in Preussen lebte (Lucaniden: *Lamprima*, etc.). Wie anders würden wir über die Urheimat und Verbreitungswege einer heute circumtropischen Ordnung (Termiten) denken, deren ursprünglichste noch lebende Gattung nur in Australien heimisch ist, wenn wir nicht wüssten, dass diese selbe ursprüngliche Gattung (*Mastotermes*), wie man sich durch einen Besuch der unvergleichlichen Sammlungen des British Museum jederzeit überzeugen kann, im Oligocän auf der Insel Wight lebte und, wie jüngst K. v. ROSEN gezeigt hat, noch im Miocän in Kroatien vertreten war, und wenn uns unbekannt wäre, dass es im Tertiär sowohl in Nordeuropa als in Nordamerika zahlreiche Termiten gab aus Gattungen, welche heute nur in heissen südlichen Ländern existieren! Sogar die heute nur äthiopische Gattung *Glossina* im Miocän.

TABELLE IV.

<i>Heutige Verbreitung :</i>	<i>Zahl u. Fundorte der im Tertiär vorkommenden Genera :</i>
Mitteleuropa	1. Oligocän Brit. Columb.
Nearktisch	8. Baltischer Bernstein
Neotropisch	9. Mioc. u. Oligoc. Europa, 1 Olig. Nordamerika
Indomal. u. Ostasien	13. Balt. u. Sicil. Bernstein
Aethiopisch	3. Oligoc. u. Mioc. Europa, 1 Mioc. Nordamerika
Australisch	7. Oligoc. u. Mioc. Europa
Mediterran, Südafrika	1. Mioc. Nordamerika
Mediterran, Australien	1. Balt. Bernstein
Medit., Indomal., Ostasien	1. Balt. Bernstein
Medit., Oriental., Aethiopisch	1. Miocän. Nordamerika
China, Nordamer., Afrika	1. Balt. Bernstein
Nordaf., Malay., Madag., Neotrop.	1. Balt. Bernstein
Ostas., Malay., Austral., Westafrika	1. Oligoc. Europa
Ostas., Indomal., Aethiop., N. u. S. Amerika	1. Balt. Bernstein
Nordamer., Centralamer., Indien.	1. Balt. Bernstein
Nordamer., Südamer., Aethiopisch	2. Sicil. u. Balt. Bernstein
Centralamer., Orientalisch	1. Oligoc. u. Mioc. Europa
Neotropisch, Indomalayisch	3. Balt. Bernstein
Neotropisch, Australisch	1. Balt. Bernst., 1 Miocän. Nordamer.
Neotropisch, Orientalisch, Aethiop.	1. Balt. Bernstein
Neotropisch, Oriental., Australisch	2. Mioc. u. Oligoc. Europa
Neotropisch, Austral., Aethiopisch	2. Balt. Bernstein
Orientalisch, Aethiopisch	5. Oligoc. u. Mioc. Europa
Orientalisch, Australisch	1. Sicil. Bernstein
Oriental., Aethiop., Australisch	6. Oligoc. u. Mioc. Europa
Circumtropisch (einzeln in Med. Ostas. Nordamer.)	9. Oligoc. u. Mioc. Europa, 1 Mioc. Nordamerika

in Nordamerika oder die heute ostmediterran-afrikanische Gattung *Halter* oder die heute auf Australien und Südamerika beschränkten *Tenthrediniden* der *Perga*-Gruppe damals in Nordamerika oder sogar heute malayische Ameisen in Europa leben konnten, können wohl sehr viele andere Typen der südlichen Hemisphaere früher auf den Nordkontinenten verbreitet gewesen sein, und wir müssen uns hüten, aus dem "Nichtgefundensein" auf ein "Nichtvorhandensein" zu schliessen.

Es würde zu weit führen, hier eine Liste der zahlreichen bis jetzt festgestellten Beispiele zu bringen, welche uns die Palaeontologie der Insekten bereits in oben angedeutetem Sinne liefert—sie wird an anderem Orte erscheinen. Hier sei nur eine kurze Tabelle eingefügt, aus welcher die Unterschiede zwischen einst und jetzt recht deutlich hervorgehen, und welche uns zeigt, wie unendlich wichtig eine gründliche Bearbeitung des riesigen tertiären Insektenmaterials nach dem Muster der neuesten Arbeiten von ULMER (*Trichoptera*), BURR (*Forficulidæ*), SHELFORD (*Blattidæ*), ENDERLEIN (*Psocidæ*), MAYR, EMERY, WHEELER (*Formicidæ*) u. a. für die Palaeogeographie wäre!

Gegen die auf analytischen Wege konstruierten tertiären Landbrücken zwischen den drei grossen Südkontinenten erheben sich also einige Bedenken und diese Bedenken steigern sich, wenn man berücksichtigt, dass die sogenannten "grossen" Übereinstimmungen oder "innigen" Beziehungen zwischen den Faunen von Südamerika, Afrika, und Australien doch eigentlich auf einer recht geringen Zahl von Belegen beruhen, gering im Vergleiche zu der Zahl jener Elemente, auf welchen die augenfällige Verschiedenheit der betreffenden Faunen beruht und welche in den analytischen Arbeiten kaum zur Geltung gelangen. Bei dem mangelhaften Stande unserer Kenntnisse über viele rezente und über noch viel mehr fossile Tiergruppen häufen sich bei Anwendung der analytischen Methode, welche nur mit Einzelfällen arbeitet, die Fehlerquellen in bedenklicher Weise und die Rolle, welche der "Zufall" in diesen Sachen spielen kann, kommt in keiner Weise zum Ausdrucke.

Es dürfte daher an der Zeit sein, die Ergebnisse der analytischen Methode durch Anwendung einer anderen Methode zu kontrollieren, bei welcher die Rolle des Zufalles möglichst aus-

geschaltet wird, also durch Anwendung einer mit möglichst grossen Massen arbeitenden Statistik, welche uns den Grad der Verwandtschaft der einzelnen Faunen veranschaulichen könnte.

Die Palaeontologie lehrt uns, dass die heute noch lebenden Insekten*species* durch das Pleistocän und jedenfalls in das oberste Tertiär, ausnahmsweise auch bis in das ältere Tertiär reichen, die *Genera* dagegen meistens in das ältere Tertiär und gewiss zum Teil auch bis in die obere Kreide. Dementsprechend werden wir zur Feststellung der jüngsten Veränderungen der Erdoberfläche die *Species*, für ältere Vorgänge dagegen die *Genera* berücksichtigen müssen.

Grössere Zahlen identischer *Species* finden wir (abgesehen natürlich von den verschleppten kosmopolitisch gewordenen) nur in benachbarten Faunengebieten, bei welchen noch heute ein Faunenaustausch leicht möglich ist, ausserdem aber zwischen der palaearktischen und nearktischen Region, welche heute durch Meer getrennt sind. Wir können also daraus schliessen, dass diese zwei Gebiete noch in recht junger Vergangenheit in Landverbindung standen—wie das jetzt wohl ganz allgemein angenommen wird.

Um den älteren Landverbindungen näherzutreten, habe ich 16,100 *Genera* aus den verschiedensten Insektengruppen bzw. Biocoenosen mit zusammen etwa 180,000 Arten, also etwa ein Drittel aller Insekten in einer Tabelle registriert, welche alle Regionen im Sinne WALLACE und alle zwischen diesen möglichen Kombinationen enthält. Tabelle auf der nächsten Seite :.

P = Palaearktisch, N = Nearktisch, S = Neotropisch, Ae = Aethiopisch, O = Orientalisch, A = Australisch.

Ein Blick auf diese Tabelle zeigt die auffallend grosse Zahl der nur auf eine Hauptregion beschränkten *Genera* und bestätigt somit glänzend die Einteilung von WALLACE. Relativ hoch ist auch die Zahl der *Genera*, welche über alle Regionen verbreitet sind (434). Im Übrigen finden wir die höheren Zahlen nur dort, wo es sich um eine Kombination von unmittelbar benachbarten Gebieten handelt, während alle wirklich diskontinuierlichen Verbreitungen schwach vertreten sind. Man vergleiche N.P. mit 575, S.N.P. mit 223, P.O. mit 362, P.Ae.O. mit 187, P.Ae. mit 180, N.S. mit 660, O.A. mit 319, Ae.O. mit

TABELLE V.

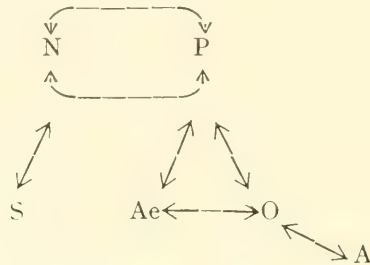
S	N	P	.	.	.	1859		.	N	P	Ae	.	A	9 (1859)	.	N	.	.	A	16
.	N	.	.	.	.	797		.	.	P	O	.	362		S	N	.	O	A	12
S	.	.	.	.	.	3437		.	.	P	Ae	O	.	187	S	N	Ae	O	.	11
.	.	.	Ae	.	.	2249		.	.	P	Ae	.	.	180	.	N	.	O	.	9
.	.	.	.	O	.	1641		.	.	P	Ae	O	A	151	.	N	.	O	A	4
.	.	.	.	.	A	1400 (11383)		.	.	P	O	.	A	106	.	N	Ae	O	A	4
.	N	P	.	.	.	575		S	.	P	.	.	.	89	S	N	Ae	.	A	3
S	N	P	Ae	O	A	434		.	.	P	.	.	A	46	.	N	Ae	O	.	2
S	N	P	.	.	.	223		S	.	P	Ae	O	A	45	.	N	Ae	.	.	2
.	N	P	O	.	.	98		S	.	P	Ae	.	.	18	.	N	Ae	.	A	— (811)
S	N	P	O	.	.	81		S	.	P	O	.	.	16	.	.	.	O	A	319
S	N	P	O	A	.	75		S	.	P	.	.	A	11	.	.	Ae	O	.	182
S	N	P	Ae	O	.	71		.	.	P	Ae	.	A	11	.	.	Ae	O	A	80
S	N	P	.	.	A	64		S	.	P	Ae	.	.	7	S	.	.	O	.	36
S	N	P	Ae	.	.	44		S	.	P	O	.	A	5	S	.	.	O	A	26
.	N	P	.	.	A	38		S	.	P	Ae	.	A	4 (1238)	S	.	Ae	O	A	20
.	N	P	Ae	O	.	34		S	N	.	.	.	.	660	S	.	Ae	O	.	14 (677)
.	N	P	Ae	O	A	34		S	N	.	Ae	O	A	27	S	.	Ae	.	.	41
.	N	P	Ae	.	.	33		S	N	.	O	.	.	24	.	.	Ae	.	A	28
.	N	P	O	A	.	27		S	N	.	.	.	A	20	S	.	Ae	.	A	7
S	N	P	Ae	.	A	19		S	N	.	Ae	.	.	17	S	.	.	.	A	56 (132) 4717 16100

182 einerseits und anderseits S.Ae.A. mit 7, S.A.O. mit 26, N.Ae. mit 2, N.O.A. mit 4, und so weiter und wird wohl bald den Eindruck gewinnen, dass es sich bei diesen kleinen Zahlen vielfach um die Rolle des Zufalles handeln könne. Um nun diesem Faktor näher zu kommen, habe ich die Verbreitung von 8,300 Gattungen aus den verschiedensten Gruppen näher untersucht und alle jene notiert, welche sicher auf einem "Zufall" beruhen, insofern als die betr. Gattung unbedingt in einem Zwischengebiete gelebt haben muss oder lebt, wo sie bisher weder fossil noch lebend nachgewiesen werden konnte, also z. B. Südeuropa Australien, Mitteleuropa Oceanien, Palaearktisch Cap, Centralasien Madagaskar, Mitteleuropa Neuguinea, Mitteleuropa Chile, Ostasien Ostafrika u. s. w. und habe gefunden, dass solche Fälle etwa 4% der Gesamtzahl betragen.

Rechnen wir alle Zahlen aus obiger Tabelle zusammen, welche als Belege für die südlichen Landbrücken der Analytiker (Archihelenis, Archinotis, Archigalenis, Pacila, Atlantis) in's Treffen geführt werden können, so werden wir kaum mehr als 4% von 16,100 erhalten und eine weitere Untersuchung wird uns bald zeigen, dass selbst unter dieser ohnehin schon recht geringen Zahl von "Beweisen für enge Beziehungen" noch so mancher steckt, der einer sorgfältigen Kritik nicht Stand zu halten vermag, was ich an anderer Stelle näher auszuführen gedenke.

Ziehen wir die Bilanz aus vorstehender Tabelle, so ergibt sich in Zahlen ausgedrückt folgender Verwandtschaftsgrad zwischen den einzelnen Hauptregionen: P.N. 1858 (1225), N.S. 1785 (1159), P.O. 1742 (1083), O.A. 1369 (754), O.Ae. 1312 (701), P.Ae. 1290 (687), P.S. 1215 (571), P.A. 1079 (472), N.O. 947 (306), S.O. 913 (259), Ae.A. 886 (327), S.A. 828 (228), S.Ae. 791 (195), N.A. 786 (197), und N.Ae. 744 (159), wobei einerseits die ganz oder fast kosmopolitischen Formen mitgerechnet, anderseits weggelassen sind. Die Verwandtschaft von Südamerika Afrika, Südamerika Australien, und Afrika Australien ist also geringer als jene von Südamerika Ostindien, Nordamerika Ostindien, und kaum verschieden von jener zwischen Nordamerika u. Australien. Es treten also schon aus dieser ganz rohen Statistik die Hauptwege der Verbreitung der modernen

(kainozoischen) Insekten und gewiss aller anderen kainozoischen echten Landtiere hervor :



Entspricht diese Annahme den Tatsachen, so müssen sich auch gewisse Zwischengebiete ziffermässig als solche nachweisen lassen :

Zwischen N. u. S. liegt Zentralamerika. Von 1172 daselbst vorkommenden Gattungen, deren Auswahl selbstverständlich ganz mechanisch ohne Rücksicht auf das Thema erfolgte, sind 201 endemisch, 353 ausserdem in N. u. Südamerika, 337 nur in Südamerika, 239 nur in Nordamerika vertreten, in Zentralamerika und Europa 30, in anderen Gebieten 12. $12 + 30$ entspricht fast genau den 4 Zufallsprozenten.

Auf dem Wege zwischen Indien und Afrika liegt Madagaskar. Von 826 dort nachgewiesenen Gattungen sind 308 Endemiten, 335 auch im indomalayischen Gebiete und in Afrika, 94 nur in Afrika, 63 nur in Ostindien, 10 in Australien Ozeanien, und 16 in anderen Gebieten vertreten. $10 + 16$ ist weniger als 4% von 826.

Zwischen O. u. A. liegt Neuguinea. Von 539 dort lebenden Gattungen sind 81 endemisch, 264 auch im indomalayischen und australisch-ozeanischen Gebiete vertreten, 144 nur im ersteren, 37 nur in letzterem, 8 im holarktischen und 5 im neotropischen. $8 + 5$ ist weniger als 4% von 539.

Setzen wir eine südliche Verbindung von Australien und Südamerika voraus, so würde dort Neuseeland dieselbe Rolle spielen wie oben Madagaskar oder Neuguinea, d. h. seine Fauna müsste annähernd gleich starke Beziehungen zu Australien und Südamerika aufweisen. Tatsächlich verhält es sich aber folgendermassen : Von 246 in Neuseeland vorkommenden Gattungen sind 80 endemisch, 64 auch in Australien u. Ozeanien, 64 nur in Australien, 11 in Ozeanien u. Neuguinea, 14 im indo-

malayischen Gebiete, 5 in Südamerika, und 8 in anderen Gebieten vertreten. 5 + 8 macht etwa 5% von 246.

Wären die ozeanischen Inseln der Rest eines tertiären Kontinentes, der die alte Welt mit Amerika verband, so müsste sich diese Tatsache gleichfalls in der ozeanischen Fauna noch erkennen lassen, was aber nicht der Fall ist: Von 436 in Ozeanien vertretenen Gattungen sind 76 endemisch, 198 auch in Australien und in der orientalischen Region, 84 im indomalayischen Gebiete (+ Neuguinea), 50 in Australien + Neuseeland, 16 in der palaearktischen Region u. anderen Gebieten, aber nur 9 in Amerika, und 3 in Amerika u. Afrika vertreten. 9 + 3 ist nicht ganz 3% von 436.

Eine ähnliche Sprache sprechen die Faunen von Chile-Patagonien, Südafrika, Australien-Neuseeland, wenn wir sie in Bezug auf ihre Beziehungen zu den benachbarten Gebieten analysieren:

Von 530 im chilenisch-patagonischen Gebiete vorkommenden Gattungen finde ich 483, welche ausgesprochene Beziehungen zu der Fauna der nördlicheren Gebiete erkennen lassen, 36 mit fraglich nördlichen, und nur 11 mit möglicherweise südlichen, d. h. antarktisch-australischen Beziehungen. Also kaum mehr als 2%!

Von 1039 südafrikanischen Gattungen zeigen 960 ausgesprochen und 71 fraglich palaearktisch orientalische und nur 8 (?) südliche also südamerikanische oder australische Beziehungen. Also weniger als 1%!

Von 1328 australisch-neuseeländischen Gattungen fand ich bei 1070 ausgesprochen und bei 231 fraglich nördliche Beziehungen, bei 27 fraglich südliche. Also wieder etwa 2%!

Ich kann also an "enge" Beziehungen zwischen den Faunen der drei um die Antarktis gelagerten Gebiete mit bestem Willen nicht glauben, denn die "Beweise" fallen in die Sphaere des Zufalles.

Was nun die einzelnen schon oben erwähnten, von den Anhängern der analytischen Methode konstruierten hypothetischen grossen Landbrücken betrifft, so muss ich gestehen, dass ich die Möglichkeit ihrer Existenz *während des Kainozoikums* auf Grund meiner Untersuchungen entschieden leugnen muss, denn solche kainozoische Landverbindungen müssten deutliche Spuren auch in der Insektenfauna der betreffenden,

durch diese Brücken verbundenen Gebiete zurückgelassen haben. Ich finde diese Spuren nicht:

Hätte noch im Tertiär eine "*Pacila*" im Sinne v. IHERINGS existiert, so müssten mehr als 5 von den untersuchten 336 ozeanischen bzw. zentralamerikanischen Gattungen (1·5%!) als Beleg dafür anzuführen sein. Hätte eine "*Archigalenis*" im Sinne v. IHERINGS existiert, so müssten mehr als 3 noch dazu fragliche von den 1153 diesbezüglich geprüften nordostasiatischen bzw. zentralamerikanischen und californischen Gattungen (nicht einmal $\frac{1}{3}$ %!) dafür sprechen.

Hätte es eine tertiäre "*Archhelenis*" im Sinne v. IHERINGS gegeben, so müssten entschieden mehr als (?) 14 von 1257 geprüften westafrikanischen bzw. brasilianischen Gattungen (etwas über 1%!) für eine solche sprechen.

Wären die Südspitzen Amerikas, Afrikas, und Australiens noch im Tertiär durch die "*Archinotis*" v. IHERINGS verbunden gewesen, so müssten wohl mehr als fragliche 22 von 1284 geprüften Gattungen (1·7%!) auf diese Tatsache hinweisen, ebenso wie eine tertiäre "*Atlantis*" im Sinne SCHARFFS durch mehr als fragliche 7 von 1039 nordafrikanischen bzw. zentral- u. südamerikanischen Gattungen (0·6%!) belegt sein müsste.

Wenn ich es nun versuche, auf Grund der oben angeführten, auf statistisch-analytischem Wege gewonnenen Resultate Karten der ehemaligen Verteilung von Land und Wasser zu konstruieren, so geschieht es in dem Bewusstsein, dass uns wohl die Rekonstruktion der einstigen Meere in jenen Teilen der Welt, welche heute über Wasser liegen nach und nach durch geologische Aufnahmen so weit gelingen kann, dass man für diese Gebiete ziemlich genaue Karten für die einzelnen geologischen Phasen, also für relativ kurze Zeitperioden erhalten wird. Viel schlimmer steht es naturgemäss mit jenen ungleich grösseren Gebieten, welche heute von Wasser oder ewigem Eise bedeckt sind, denn hier muss die hypothetische Rekonstruktion auf Grund tier- und pflanzengeographischer Befunde den grössten Teil der Arbeit leisten. Nach meiner festen Überzeugung werden diese Befunde *nie* genügen, um *genaue* Karten für die *einzelnen Unterabteilungen* der Perioden zu errichten, sie werden umso unsicherere Resultate liefern, je weiter wir in die Vergangenheit zurückgreifen, weil wir trotz aller Fossilfunde nie genau ermitteln

können, in welchem Zeitpunkte eine Verbreitung eintrat. Das Einzige, was wir mit einiger Berechtigung unternehmen können, ist eine rein schematische Darstellung der hauptsächlichlichen Verbreitungswege mit annähernder Angabe der Zeit, in welcher sie gangbar waren. Wenn wir z. B. eine alttertiäre Verbindung von Australien und Indien annehmen, so soll damit noch nicht gesagt sein, dass diese durch das ganze Eocän u. Oligocän unveränderlich war u. s. w.

In diesem Sinne wünsche ich die beigegebenen Kartenskizzen aufgefasst zu sehen. Sie wollen nur zeigen, wie ich mir die Veränderungen der Erdoberfläche für die Zeit von der obersten Kreide bis zur Gegenwart vorstelle, welche Landverbindungen mir einerseits unerlässlich erscheinen, um die heutige Verteilung der Organismen erklären zu können, und welche von anderer Seite vorgeschlagenen Landbrücken mir durch das Tatsachenmaterial widerlegt erscheinen.

Karte II bezieht sich auf die obere Kreidezeit: Ein riesiger nördlicher Kontinent verbindet das östliche Nordamerika über Island-Grossbritannien und Skandinavien mit dem nördlichen Asien und reicht von dort weiter in das westliche Nordamerika. Vermutlich fand dieser westamerikanische Teil seine Fortsetzung nach Süden bis nach Südamerika und eine Fortsetzung des nordasiatischen Landes reichte über das malayische Gebiet und Neuguinea bis Australien, Tasmanien und Neuseeland. Nahe an dieses Gebiet reichte offenbar ein grosses Festland, welches Vorderindien mit Madagaskar verband, aber vermutlich noch von dem grossen afrikanischen Lande getrennt war. Afrika reichte jedenfalls über das Rote Meer nach Arabien, war aber in seinem nördlichen Teile noch von den Wässern der "Thetis" überflutet, jenem riesigen Mittelmeere, in welchem gewiss eine Anzahl mehr oder minder grosser Inseln verteilt war. Jedenfalls gab es auch im Bereiche des Stillen Ozeans mehrere Reihen grösserer Inseln, von denen die nördlichsten, die Sandwich-Inseln, vermutlich durch andere heute verschwundene Inseln näher an die umliegenden Kontinente herangerückt waren, als heute. Die Capverden und vielleicht auch Ascension und St. Helena standen mit dem afrikanischen Kontinente in Verbindung, die Bermudas vielleicht mit dem östlichen Nordamerika. An das westamerikanische Land mögen die süd-

californischen Inseln und die Galapagos angeschlossen gewesen sein. Der südliche Teil Südamerikas sowie der gegenüberliegende Teil der Antarktis scheinen grossenteils überflutet gewesen zu sein, doch dürfte eine grössere antarktische Landmasse bestanden haben, die jedoch durch breite Meere mit Inselgruppen von den anderen Landmassen getrennt war.

Karte III soll die Verhältnisse im Alttertiär darstellen: Der grosse eurasiatische Kontinent war entzweilerissen, aber nach beiden Seiten mit Amerika in Verbindung, dessen beide Hälften sich nun verbanden. Südamerika dürfte zeitweise von diesem Lande getrennt gewesen sein. Die Verbindung von Hinterindien scheint schon zerfallen gewesen zu sein, aber das indomadagassische Land dürfte sich dem afrikanischen Kontinente angeschlossen haben, welcher sich seinerseits weiter nach Norden auszubreiten begann und nebst der Vergrösserung der süd-europäischen Inseln an der Einengung der "Thetis" mitwirkte. Die westlich von Amerika liegenden Inseln waren vermutlich teilweise noch in Landverbindung, ebenso die Azoren mit Spanien, die Canaren u. vielleicht Capverden mit Nordafrika. Die Antarktis dürfte annähernd in ihrer heutigen Form existiert haben. Die Bermudas waren wohl mit Nordamerika, Westindien mit Florida und (?) Zentralamerika, Japan mit Ostasien, Arabien mit Afrika, Ceylon mit Vorderindien in Verbindung u.s.w.

Wenn wir in Rechnung ziehen, dass damals erwiesenermassen Laubpflanzen und darunter ausgesprochen thermophile Formen bis in die Gegend des 70. Grades nördlicher Breite reichten, so werden wir kaum irren, wenn wir die warme Zone, welche heute etwa 80 Grade der Aequatorialgegenden umfasst, für das Alttertiär auf etwa 140 Grade erweitern. Wir werden dann ganz gut begreifen, dass damals auch solche Formen, welche wir für ausgesprochen wärmeliebend halten, kein Hinderniss fanden, sich nördlich zirkumpolar zu verbreiten. Dementsprechend mag sich in dem heute so gut wie unbewohnten Gebiete nördlich des 75. Grades eine Fauna ausgebildet haben, wie wir sie jetzt im gemässigten Gürtel der nördlichen Halbkugel finden. Es ist wohl anzunehmen, dass das antarktische Gebiet damals auch wenigstens an den Rändern von wärmeliebenden Elementen und von solchen des gemässigten Klimas bewohnt war, aber sicher von einer ganz anderen Fauna wie die grossen Nordkontinente.

Karte IV will zeigen, in welcher Art sich während der jüngeren Tertiärzeit eine Annäherung an die heutigen Verhältnisse vollzog. Der europäische Kontinent trat wieder mit dem ostasiatischen in Verbindung. Von Europa reichte eine (? zeitweise) Brücke auf dem alten Wege nach Grönland und jedenfalls dadurch nach Nordamerika. Auch die Berings-Brücke dürfte zeitweise über Wasser gewesen sein, ebenso die Verbindung von Nord- und Südamerika, an welcher letzteres sich die chilenischen Inseln und vermutlich das Feuerland und die Falklandsinseln anschlossen. Vorderindien trennte sich von Madagaskar, welches vorläufig noch mit Afrika in Verbindung blieb, und schloss sich durch weitere Reduktion der "Thetis" dem asiatischen Kontinente an. Afrika war nun einerseits von Indien getrennt, trat aber nach und nach in engere Beziehungen zu Südeuropa und Vorderasien. Die malayisch-papuasische Gebiete waren jedenfalls in wechselnder Verbindung mit Australien, so dass sich fliegende Formen verbreiten konnten. Japan war vermutlich noch nicht isoliert, ebenso Tasmanien, dagegen Neuseeland schon getrennt, ebenso die Galapagos und die meisten anderen Inseln, welche in den grossen Ozeanen verteilt sind. Eine Verbindung zwischen der Antarktis und den drei südlichen Kontinenten bestand höchstens aus Inselreihen. Anfangs wenigstens scheint die warme Zone noch bis zum 65. Grade gereicht zu haben, so dass selbst im Miocän noch ein Verkehr thermophiler Organismen über die ganze nördliche Hemisphäre möglich war; im Pliocän mögen dann nur mehr die Elemente des gemässigten u. kalten Klimas über die beiden Brücken gelangt sein, woraus sich zwanglos die weitgehende sogar auf Species sich erstreckende Übereinstimmung der beiden arktischen Faunen erklärt.

Karte V soll uns ein Bild von dem Einflusse geben, welchen die diluvialen Eiszeiten auf die Verbreitung der Organismen ausübten. Die Verteilung von Land und Meer war damals wohl annähernd der heutigen ähnlich. Ein Rest der Islandbrücke dürfte noch bestanden haben. Der dunkelste Ton auf dieser Karte bezeichnet jene Gebiete, welche heute schlechtweg als "vereist" angenommen werden können. Der mittlere Ton soll andeuten, wie weit beiläufig diese Vereisung an dem Höhepunkte der Eiszeiten reichte, und der lichteste Ton gibt jene Gegenden an, welche damals für Organismen des kälter

gemässigten Klimas gangbar gewesen sein mögen. Ich nehme dabei den nicht widerlegten Fall an, dass die Kälteperioden sich gleichzeitig auf die ganze Welt erstreckten und daher die Zone der ausgesprochen Thermophilen, welche heute 80 Grade umfasst, auf weniger als die Hälfte eingeengt war.

An der Hand dieser Karte können wir uns wohl vorstellen, dass während der Eiszeiten solche Elemente, welche früher ausschliesslich in nördlichen Gebieten gewohnt hatten, nach und nach gegen den Aequator gedrängt wurden und auf den drei angedeuteten Wegen über die tropische Zone hinaus nach Süden gelangten. Eine postglaziale wärmere Periode mag dann viele dieser Formen von ihrer nördlichen Heimat abgeschnitten und in Gebieten ausgerottet haben, in denen sie nach heutigen Verhältnissen leben könnten.

Ein Blick auf diese Karte zeigt uns auch, warum die antarktische Land-Fauna im Vergleiche zur arktischen so unendlich arm ist: Während der letzten grossen Eiszeit der Südhemisphäre war die vielleicht in viel älteren Zeiten existierende Landverbindung zwischen der Antarktis und den Südkontinenten längst zerrissen und die antarktische Landtierwelt konnte daher in ihrer Masse nicht gleich der arktischen während der Vereisungszeit aequatorwärts wandern, um später wieder näher an den Pol heranzurücken.

Um zu zeigen, wohin uns das voreilige Konstruieren von Landbrücken führt, habe ich es versucht, auf Karte VI nur die wesentlichsten von den in jüngerer Zeit für das Kainozoikum angenommenen Landbrücken zu kombinieren. Sollten alle hiebei berücksichtigten Autoren Recht haben, so wären nur einige kleine Tümpel der Ozeane während dieser Zeit permanent geblieben und die littoralen marinen Faunen hätten in dieser relativ kurzen Zeit beständig enorme Wanderungen ausführen müssen. Es müsste, wäre dem so gewesen, nicht nur die heutige und einstige Verbreitung der Meerestiere eine ganz andere sein als sie es ist, sondern auch die Unterschiede zwischen den Landfaunen der einzelnen Regionen müssten ausschliesslich auf ökologischem Wege zu erklären sein, was bekanntlich absolut nicht der Fall ist. Die Tropenzone aller Kontinente und Inseln müsste eine fast spezifisch identische Fauna haben und die tatsächlich existierenden enormen Unterschiede wären nicht erklärlich.

GEOGRAPHICAL DISTRIBUTION AND DOMINANCE IN RELATION TO EVOLUTION AND PHYLOGENY.

By JOHN W. TAYLOR, HORSFORTH.

(Plates VI-X.)

THE geographical distribution of life over the world is a subject of far-reaching importance, bearing not only upon the origin and dominancy of the various species and groups, but, when properly understood, largely assisting to explain their phylogenetic relationship, their place of origin, and the probable route or routes by which the world has been populated; but I should scarcely have ventured to press the subject on your notice, as worthy of more attention than it has hitherto received from entomologists, but for the suggestion and kindly encouragement of our distinguished President--yet the study would undoubtedly materially help to explain many of the mysterious problems of insect genealogy and distribution.

Even at the present day there are scientific men who fail to see that the distribution of life is an abstruse and important problem, and that its dispersal is *not* accomplished by chance or by the scattering at random of species and individuals, but is a process governed by great and universal laws, and although the natural tendency is, or may be, towards uniform diffusion in all directions, this is prevented or hindered by physical or organic barriers, and dispersal therefore tends in a large measure to follow certain definable paths.

The physical obstacles to uniform dispersal are mountain chains, deserts, marshes, rivers, arms of the sea, or any natural features dissimilar to those to which the particular species or genus is more especially adapted. Some of these barriers to dispersion have apparently been permanent throughout vast geological periods, but in most cases effective barriers have been

formed *after* considerable diffusion of the earlier types of life had taken place.

The brilliant researches of SEMPER, PILSBRY, and others into the organisation of the Mollusca, enable us to indicate the probably true evolutionary area of the chief types of structure, not only of special genera, but of other more important groups, and to map out the probable routes by which the earth has become populated, for although evolution, in a lesser degree, is a characteristic of every region, the theatre of the evolution of the great groups of all forms of life appears to have been much more restricted, and a consideration of all the circumstances inclines one to the belief in a chief or predominant evolutionary area, in which have arisen the more important types of structure at present inhabiting the globe. The evolutionary area of the chief types of terrestrial life is the Palæarctic region, but it is in North Central Europe that the *originating* force is most strongly exercised, the species or groups arising there being more highly endowed and better qualified to succeed in the life-struggle than the organisms that may have preceded them or may have arisen elsewhere, leading us to expect what has actually occurred, that the species of the European region (Pl. VI, fig. 1), being naturally superior to all their competitors, were bound eventually, as they have done, to overwhelm and extirpate the evolutionary products of every other country, and to multiply and spread, while improved races or species would continue to arise at the theatre of greatest evolutionary activity, gradually dispossessing their predecessors and driving them farther and farther afield, a process which would be repeated and continued on the advent of each new and improved species or group.

In this way we have throughout the globe the most highly organised and predominant groups or species (Pl. VI, fig. 2) inhabiting the most active evolutionary district, with a gradual diminution of dominating power as we proceed therefrom: thus we have constituted a Chronological Series, or Index to the relative antiquity of the different groups, by the geographical position they occupy in relation to the area from which they emanated, and the farther removed any country or area is from the assumed creative centre, the more ancient and primi-

tive the group or species and the less able to spread against or resist the advancing tide of later developed and relatively superior species.

Although the more simply organised and primitive forms of life are now so widely diffused, it is owing to their vast antiquity that this has been attained, their enormous range in time enabling them to overspread the globe by taking advantage of the probably numerous geographical changes that have occurred.

The simpler and more primitive the species or group and the more ancient its origin, the wider and more discontinuous will be its range in space, for the more recently evolved and more highly organised forms have a compact yet comparatively restricted distribution at, or near, their evolutionary area, and exhibit Dominance or Superiority, a characteristic evidenced by continuity of distribution, abundance of individuals, and by a wealth of variation, which is an indication of the plasticity of the organism and its power of adaptation to a great variety of conditions, a power possibly due to the greater physiological efficiency of its organs.

The incessant encroachment upon the territories of the less highly organised forms by the most advanced organisms, implies and confirms that faunas and floras are, under normal conditions, always in a state of slow and persistent transition, imperceptible changes slowly but none the less surely going on, for it is universally conceded that, prior to the life existing at the present time, many previous forms had lived and been dispersed over the globe, and as surely became extinct and replaced by the improved races that have successively followed them, and though every group of organisms has a certain area or region in which for a period its metropolis is placed, yet the site of this aggregation is undoubtedly always undergoing a slow and gradual displacement in position, but always in a direction *away* from its original home or region in which it was evolved, and to which it can *never* naturally return.

This universal migratory movement is due not merely to the increase in numbers, but to the pressure of the subsequently evolved more advanced races which come in contact and competition with them, and will assuredly in course of time

successively occupy the territories now inhabited by their predecessors.

This law of life is of universal application, and is the final expression of that deadly struggle to which all life is committed. It is Nature's law that the weak must give place to the strong, for the latest developed and most vigorous species will always prevail against the older and more primitive forms, and, bearing this in mind, we must regard as illogical and untenable any theory or belief that the primitive species or groups can extend their range to the disadvantage or detriment of the superior and stronger forms of life. As reasonably might we apprehend that the lower and more degraded races of mankind could invade the European region and overcome the Europeans.

Speaking broadly, there has thus been no interchange of life between different regions, and no probability or even possibility of any permanent invasion or occupation of the Palearctic, and more especially the mid-European region, by Arctic, Asiatic, African, or American forms of life, all of which are confessedly inferior to the inhabitants of Europe, and could not long survive in competition with them if brought here, as the species now inhabiting all these more primitive countries are members of genera or families which probably emanated from the European region and have mostly been expelled therefrom by the species afterwards evolved there.

Thus Australia, New Zealand, South America, or any other archaic region, would assuredly not have remained so primitive in their fauna and flora if these countries had possessed any degree of evolutionary activity, or if the more or less complete isolation from which they have suffered had not so effectually shut out the superior life which was being evolved in Western Palearctica, for then the Marsupial and other ancient forms of life would have long ago ceased to exist or have lost their local dominancy and been compelled to adopt nocturnal, subterranean, or other modes of life, take refuge in forest recesses, ascend lofty mountains, or become isolated in desolate and uninviting districts, so that the severity of their struggle for life with more dominant species must be greatly mitigated or temporarily cease: for it is only by such methods that some-

remnants of the more primitive species are for a time preserved from the stress of competition with superior life.

Dr. MALCOLM BURR has placed on record, under the expressive title of *A Faunistic Island*, the existence of such a sanctuary at Oberweiden in Moravia, which he describes as a dry and desolate spot of limited extent, whose only growth was a little coarse grass and a few stunted shrubs; yet over eighty species of Orthoptera have been obtained there, which are believed to represent the fauna of Central Europe at some previous era, as all the species were quite different from those inhabiting the surrounding country, and bore most resemblance to the fauna now existing in the Valley of the Volga, and therefore may be regarded as confirmatory evidence of the true direction of the migratory flow of life from Europe.

The great faunal richness in ancient types of this isolated and barren spot is quite analogous to the immense variety of life to be found congregated together in the weaker regions of the earth, and argues these countries to be also refuges or sanctuaries of the regressive and decadent species and groups, as the strong and evolutionary active regions are always characterised by the presence of the most highly organised groups and species and by a greater degree of uniformity, as the primitive species are much more rapidly and completely eliminated. Even man himself furnishes corroboration of this crowding together of regressive and dying races in the more inhospitable or inaccessible districts of the weaker regions, not only by the aggregation of decadent tribes, but also by the numerous linguistic families congregated in such districts; for although there are fifty-nine linguistic families in North America, quite forty of these are found in the barren and limited area between the Pacific and Rocky Mountains, while all the rest of the sub-continent has nineteen only. The region of this notable aggregation of tongues is precisely the spot where the lowliest Helicoids are still dominant and flourishing.

In South America the same result may be seen, as although an enormous number of apparently unrelated linguistic families are congregated within the Andean and Pacific regions, yet the languages of all the rest of the country may be reduced to about a dozen groups.

Bearing in mind the unfailing results of unceasing conflicts between the highly organised and the less perfect organisms, it will be abundantly evident that no animal and no plant can be expected to establish themselves successfully and permanently or extend their range in a new country, unless they fill some previously inadequately occupied sphere of life or are manifestly greatly superior in organisation to the species already in possession of the invaded ground and representative of the most recently evolved and most highly organised of their kind, while the country invaded must have inhabitants of a more ancient and primitive type. This is exemplified by the startling results of the sudden introduction of the highest and most dominant organisms of Europe into such primitive countries as New Zealand, Australia, South America, and even Eastern North America, which are now in a large measure overrun with European animals and plants, which are driving off or exterminating the native or indigenous life, so that in many districts it is now with exceeding difficulty that any native species can be obtained near the towns or settlements, the whole aspect of the country being changed by the expulsion of the native or primeval life, which has been replaced chiefly by the dominant species of the European region.

At no time, therefore, has it been more important than now, that the primitive fauna and flora of the weaker regions of the globe should be thoroughly and adequately studied, for at no previous period in the history of the world have changes in the life of the primitive countries and the destruction and extinction of their archaic species proceeded with such alarming rapidity as at the present day, and this remarkable acceleration of extermination and change must be solely attributed to the marvellous increase in the facilities for easy and rapid locomotion, by which means man, purposely or unwittingly, transports the highly organised and adaptable animals and plants of the European region to remote and distant countries, whose animal and vegetable life are of the lowliest types, types which untold ages before had been expelled from Europe and until the present day had found sanctuary in these remote regions—a sanctuary that would long have remained inviolate but for man's interference, as in the ordinary course of natural diffusion it would have taken many thousands of years to accomplish the

transformations which have in some cases been consummated even during the lifetime of a single generation.

Not only have the indigenous animals and plants of these weaker countries been thus rapidly and completely exterminated, but the races of mankind are equally subject to these natural laws, and have been or are in process of being destroyed, and have disappeared or will shortly disappear from the face of the earth; and this destructive process will, with the continued improvements in quick and easy transit, become increasingly deadly, bringing the stronger and weaker races more rapidly into close contact and competition, with fatal effects to the indigenous races, whether men, animals, or plants: and this natural process is in relatively more or less active operation in every country.

Conversely, as showing the insuperable difficulties besetting the establishment of the indigenous inhabitants of the more primitive regions within the frontiers of more advanced countries, Mr. C. BAILEY, the eminent botanist, in his communication to the British Association at its meeting in Manchester, declared that although for very many years an enormous number and variety of seeds had been dispersed around Manchester, derived from the immense quantities of raw cotton imported from North America, Egypt, India, and other places, yet as far as known only *two* plants have thus been introduced and apparently succeeded in establishing themselves in the vicinity, and these are aquatic plants living under artificial conditions, being confined to the tepid waters of certain sections of the canals into which the warm water from the condensing steam engines is discharged.

The place of origin or evolutionary area of the terrestrial mollusca and other organisms has, however, been located by most writers in the remote, comparatively unknown and mysterious regions of Central Asia, a belief based chiefly upon unreliable mathematical calculations fixing a central point in the range of each species, and also the presence of a maximum number of species of certain genera belonging to more generalised forms of life than those of Europe, the discovery of more numerous fossil remains, or in earlier strata, than the beds of Europe containing similar relics, and the absence of evidence

that the forms now confined to Asia have ever inhabited the extreme north or south of Europe. Unless, however, the group be a dominant one, its real original home or place of origin is not necessarily indicated by the aggregation of its constituent species, as the true birthplace of a group, if it be no longer a dominant one, may not retain a single representative within its limits, its constituent species having been expelled or overcome by the stronger forms which have arisen and supplanted them—while the geological record is too incomplete and fragmentary to overthrow, by the purely negative evidence it can offer, the conclusions based upon the solid and verifiable facts of graduated perfection of structure and geographical distribution; and, so far from agreeing with the theory of the eastern origin of the various forms of life, and the reasoning by which it is supported I regard the Central Asian plateau more as a sanctuary where the weaker and less adaptable species still exist which have migrated or been expelled from the regions more immediately adjacent to the active evolutionary centre.

Central Asia has never produced anything superior to Western Palæarctic life, and there is little or no evidence that a typical continental or extreme climate, as mid-Asia must always have had, ever produced the higher types of life or has done more than modify the species which have migrated thither from Europe.

It is true that MAX MÜLLER and other eminent men believe, or formerly believed, that the Aryan or White race of mankind originated in the Highlands of Asia, but this hypothesis is now, I understand, quite discredited, and the declaration of SPIEGEL that the Aryan race arose in Europe, between the 45th and 60th parallels, which, as the region of its highest development, is probably the place where it originated, is now more generally accepted—a belief in which I cordially concur. Although distribution or dispersal has doubtless been influenced by the climatal changes the earth has undergone, these fluctuations being such that at no distant date a colder climate extended over a large part of the Northern Hemisphere, yet the severity and effect of this epoch would appear to have been somewhat exaggerated, although it was undoubtedly a very cold period and accompanied by the formation of extensive glaciers.

These frigid conditions were preceded by a warmer Miocene period during which deciduous trees and evergreens flourished within 10 degrees of the present position of the Pole, and it is probable that similar alternations of climatal severity have occurred from time to time in the history of the world, yet all these changes would be so excessively slow that if any powers of adaptability be conceded to organised life, we are compelled to allow that most of the less severe changes would have been guarded against by suitable modifications of the affected organisms in response to the gradually changing conditions to which they were subjected.

But without wishing to minimise a reasonable interpretation of the effects of these extreme conditions, all of which are of a more or less temporary character and do not vitally affect the principles involved in the distribution of life, we must, I think, come to the conclusion that a greater and more far-reaching cause has not only brought about the present distribution of life, but has been equally potent in all ages, and that cause is undoubtedly the increasing and unending struggle for existence between the various species and groups, a struggle that invariably results in the extermination or expulsion of the weaker and more primitive competitors and their eventual restriction to isolated, remote, or inhospitable regions: thus Arctic, montane, desert, or other trying conditions of life are not adopted from choice, but the organisms now living under such conditions have been compelled by the stress of competition to retreat thereto and adapt themselves to the cold or barren stations not occupied by the stronger races. The routes by which the exodus of improved forms from the active evolutionary area in Europe takes place towards Asia, America, and Australasia is by way of South Russia mainly through the stretch of country lying between the southern boundary of the Boreal province of Milachevitch and the northern boundary of the Pontic province of Drouet, and that this is the probably true path of emigrant mollusca is demonstrated by the reliable records establishing the direction and progress of the eastern dispersal of the most dominant *Helices*, *H. pomatia*, *H. nemoralis*, and *H. hortensis* (Pl. VII, fig. 3).

The correctness of this view is now accepted by one of the

most eminent scientific men of our time, Prof. H. SIMROTH, Leipzig, who wrote me some time ago, saying: "Occupied with a book on the Pendulation theory, I am astonished to find that your map of the distribution of life from Europe is nearly identical with that demanded by this theory."

The wave of life, after passing through South Russia and to the south of the Urals, is continued along the narrow but comparatively fertile tract to the north of the Central Asian desert and mountain plateau until, on nearing the Pacific coast, a furcation takes place, one branch crossing the Aleutian bridge to North America, and spreading southwards to the west of the great mountain range, and eventually occupying the entire continent; the second column turns southward, occupying China and passing into the Malay Archipelago, Australia, etc., giving off on its way a branch which travels westward to India.

Another important route (Pl. VII, fig. 4) traversed by a great group of species passes over or around the Alpine and other mountain chains, occupying the Iberian, Italian, and Balkan peninsulas, crossing to Asia Minor and Africa by the ancient land connections, and eventually traversing the Nile Valley to the south of the Sahara and opening up the whole African continent to colonisation, while a branch or column spreads towards the east by way of Persia, more slowly over-running the arid elevated country and only a few species reaching India.

Another group apparently travelled by way of the British Isles or Scandinavia, and passed over a late Tertiary bridge to the northern parts of North America; but this connection was apparently of only short duration, as comparatively few species, and all of northern range, have been enabled to take advantage of it.

The probable accuracy of the foregoing deductions, derived from the available evidence, is clearly indicated by the uninterrupted and closely connected chain of life which can be discerned, leading imperceptibly from the most primitive and archaic groups, living in the most remote regions, or occupying arid and inhospitable areas, to the most highly organised and dominant species, inhabiting the actual theatre of greatest evolutionary force.

This orderly distribution of life over the whole earth is strong evidence of its origin from a single region, as incongruity and disconnection could hardly fail to be present and recognisable if a *varied* life was originating and spreading from several independent centres.

The true direction of these migratory movements, for a believer in Evolution, is also furnished by the acknowledged fact that in all cases, wherever closely investigated, it is found that the most archaic and therefore the earliest evolved species of any group is always in the van, or farthest from the assumed birthplace or centre of dispersal, while the later developed forms are always towards the rear and nearest their place of origin.

If the species or groups had been evolved in and were spreading from Antarctica, as has been affirmed for various groups of animals and plants, then the earliest evolved should on evolutionary principles have spread farthest from their assumed birthplace, while the latest and most perfected forms would not have spread so far: thus its earliest and most modern forms would occupy positions *entirely opposite* to that of the forms spreading from Palearctica, and this is notoriously not the case, and would appear to invalidate the theory of an evolutionary Antarctica.

In the demonstration of the facts upon which the preceding generalisations are founded, I will commence with my own more especial study, the Mollusca (as it is apparently further advanced on this special line of thought than most other groups), and I shall hope to be able to show you that its geographical distribution is in strict harmony with the serial evolution of its constituent families and genera.

The **Helicidæ**, upon which the present scheme of distribution is chiefly founded, are divided by Prof. PILSBRY into four chief groups—*Belogona Siphonadenia*, *Belogona Euadenia*, *Epiphallagona*, and *Protogona*, and I have also taken note of a still lowlier and more generalised group, *Haplogona*. These groups are enumerated in the order of their comparative perfection of structure, beginning with the most highly organised group.

The *Belogona Siphonadenia*, to which the typical genus *Helix* belongs, extend over and are characteristic of the Western Palearctic region. It is the most advanced group, and its highest

manifestations are European, the more ancient and morphologically less perfect genera, *Fruticicola*, *Heliomanes*, etc., which, being early evolved, are most widely diffused and form the leading or foremost lines of advance, having spread over the Mediterranean subregion and crossed the Asiatic continent, overlapping and intermingling with the rear of the previously evolved and retreating *Euadeniate* race, which the *Siphonadenia* have supplanted in the European area, where the *Euadenia* were formerly supreme and predominant.

The *Belogona Euadenia*, which, before the advent of the *Siphonadeniate* race, were the most highly organised and dominant *Helices* in the world, are now a sub-dominant and regressive group; they formerly inhabited the European area, but at the present day have their characteristic development and metropolis in Eastern Asia, the primitive genus, *Helicostyla*, with its simple dart apparatus, constituting the most advanced section in the Eastern Hemisphere, having penetrated to the tropical islands of Indo-Malaya; a few representative species still linger in the Mediterranean region and Central Asia, but are being gradually expelled therefrom, while in Central Europe *Eulota fruticum* is now the solitary representative of this formerly dominant group.

Though this group is now a *waning* one in the Old World, it is the most dominant and highly developed one on American soil, having crossed from Asia by the Aleutian bridge and invaded North America, but, being prevented by the intervening arid mountain ranges from eastward extension, spreads southwards along the Pacific slope, eventually penetrating to South America and the West Indian Islands, probably reaching the latter area by way of Yucatan, as the group has not yet invaded the Lesser Antilles.

The *Epiphthallogona* are a more simply organised group, which preceded the *Euadenia* in the evolutionary race, originating, like the two preceding groups, within the European area, and like them were in their time the predominant race, but were compelled by their improved successors, the *Euadenia*, to evacuate their place of origin and travel the same or similar routes which the later-developed *Euadenia* followed, having been driven by them farther and farther from the evolutionary area, their

earlier developed species intermingling with the rear of their retreating predecessors.

Although the *Epiphallogona* have representative species which linger behind and are still to be found in Japan and neighbouring regions, yet their metropolis at the present day is the equatorial islands of the Indo-Malayan region and the adjacent Australian continent: the earlier developed and most primitive species always extend beyond their later developed and more highly organised congeners.

In America, they preceded the Euadeniate race, by whom they have been driven towards the south, so that at the present time they inhabit Central America, the whole of the West Indian Islands, and Northern South America, often mingling with the competitive and more dominant Euadenia, but extending beyond them on all sides *except* along the route by which the newer and stronger race are advancing.

The *Protogona* are the most simply organised and the earliest evolved of the true Helices, and in their far-off day were the predominant type of the family in the world. They were probably evolved in the same area as the races already considered, but have in process of time spread over almost every part of the habitable world, but are now entirely and completely expelled from the Palearctic region, by the several series of more advanced forms which successively followed them, so that they now exist only in the most remote and distant regions, their chief asylums being the countries farthest removed and most difficult of access from their place of origin, as the southern extremities of Africa, South America, Australia, Tasmania, and the more remote equatorial islands of Australasia, but they are closely pressed, and their rear overlapped by their Epiphallogonous successors.

The *Protogona* are, however, still the dominant and most highly organised race of Helices in the Eastern United States, being shielded from the intrusion and competition of the more highly organised Euadeniates of the Pacific slope by the intervening mountain ranges and desert regions, the Alleghanian plains being thus comparable to the countries and regions already mentioned as harbouring these primitive species.

Still lower in the scale of life are the more generalised species,

classed together as *Haplogona*, a group which is regarded as standing close to the probably now extinct common progenitor of the *Helicidæ* and their close allies, and this view is further emphasised by the world-wide distribution their immense antiquity has enabled them to attain, as representatives are found from the Arctic regions to the Antarctic. In New Zealand, Tasmania, South Australia, and South Africa its species are found abundantly, and it is the predominant Helicoid in the Oceanic islands of Polynesia and elsewhere.

In North America, this weak and ancient race is still flourishing and represented by a number of fine and large species which occupy the elevated and desert land between the Mississippi and the Sierra Nevada and other mountain ranges, which so effectually shut off the more vigorous Helicidian life of the Pacific slope.

In the European districts a few species of small size, as *Punctum pygmæum*, *Pyramidula rupestris*, etc., still exist, their reduced size and probably non-competitive habits of life probably assisting to preserve them for a period from extinction there.

In the **Oligochæta**, or earthworms, which have been studied with such brilliant results by Mr. F. E. BEDDARD and others, we have similar and corroborative evidence of the manifest superiority and dominance of the more recently evolved European group, the *Lumbricidæ*, and the probable correctness of my views as to the migratory routes by which the earthworms have overspread the world.

The *Lumbricidæ* are declared to possess a most remarkable degree of adaptability—shown by their capacity of establishing themselves anywhere and of expelling the native worms of any country, a power they share with the human race and all other organisms of their native region. They prosper in the warm extra-European countries and elsewhere, the differences of climate offering no obstacle to their prosperity and increase (Pl. VIII, fig. 6).

In gatherings of worms from the cultivated regions of New Zealand, hardly any native worms can now be found, and this is exactly the case in South America. In Australia, too, the native worms must be sought far away from the settlements,

the town gardens being now solely occupied by the European species.

The *Lumbricidæ* are naturally at the present day confined to the Palearctic region, and they are strictly analogous in dominance and distribution to the molluscan race *Belogona Siphonadenia*, and although representatives of this group are found in Eastern Canada, etc., which Mr. BEDDARD considers may have been artificially introduced, yet the species of *Heliodrilus* which are found there are amongst the earliest evolved and most widely spread representatives of the race, and it is not unlikely they have spread there in the ordinary course of natural diffusion, in company with certain species of *Helix*, etc., which are also assumed to have reached Eastern North America by means of the land connection which formerly existed across the North Atlantic.

The *Megascolecidæ*, as represented by its highest and most recently developed group, *Pheretima*, also possesses in a striking degree the power of colonisation anywhere except in regions dominated by the *Lumbricidæ*. The *Megascolecidæ* are a characteristically Eastern group, and almost precisely correspond with the Euadeniate mollusca in their relative dominancy and geographical range, the genus *Pheretima* constituting the rearmost of the retreating group, its territory being invaded by the stronger and later developed *Lumbricidæ*.

The *Megascolecidæ*, like the molluscan *Euadenia*, have also crossed the Aleutian bridge and travelled southwards along the shores of the Pacific. The genus *Pheretima*, so characteristic of China, etc., is represented by the closely allied forms *Plutellus* and *Megascolides*, belonging to the *Megascolecinae*, the same group of which *Pheretima* is the most modern representative.

In tropical Africa, the *Megascolecidæ* are represented by *Eudrilidæ* and *Dichogaster*, two quite characteristic groups.

The *Geoscolecidæ* are quite unknown in Australia, and though regarded as comparatively modern, are destitute of dorsal pores, the absence of which, as one of the indications of their originally aquatic life, bespeaks a high antiquity for the family. They are especially characteristic of Central and South America, and are found in South Africa, Madagascar, and certain parts of India

and Burma. They may be regarded as representing the *Epiphallogona* of the molluscan classification.

Mr. BEDDARD regards the *Geoscolecidae* as nearer the *Lumbricidae* than are the *Megascolecidae*, perhaps owing to the generalised *Hormogaster*, which has many Geoscolecid characters still lingering in the Mediterranean region. In South Africa and Madagascar the *Microchætinae* are represented chiefly by *Microchætus* on the continental land, while *Kynotus* is entirely restricted to Madagascar.

Similarly we find the most primitive subfamily group, the *Acanthodrilinae*, which a consideration of its distribution indicates should be raised to family rank, may be paralleled with the molluscan group *Protogona*, and like that group are chiefly found in and characteristic of the weaker and most remote parts of the earth. South America, South Africa, Australia, Tasmania, and the Antarctic islands are all inhabited by these creatures, and chiefly by one of its most archaic genera, *Notiodrilus*, and are pressed southwards by the competition of the *Geoscolecidae* or by the still more highly organised *Megascolecidae*.

In Eastern North America the resemblance to the Archaic *Protogona* is further emphasised, for we find that the genus *Microscolex*, a member of the subfamily *Acanthodrilinae*, as well as *Diplocardiinae* and *Ocnerodrilinae*, are characteristic of the region and very closely allied to *Notiodrilus*, the most primitive earthworm known, and standing nearest the assumed generalised form from which the earthworms arose.

In **Ornithology** we have the high authority of Prof. ALFRED NEWTON in support of the principles involved in the orderly dissemination of life over the globe, shown by his expressed belief in the overpowering dominance and dispersive power of the birds of the European region, and his recognition that the weaker and more primitive countries must be regarded as refuges or sanctuaries of ancient life, for he says :

The Western Palæarctic or European region has the most highly developed ornithic fauna in the world, and is the one from which the weakest types have been rigorously eliminated, and it is wonderful that the region now possesses even one peculiar family, as it should be remembered that all the families

consist of stronger forms than those inhabiting the regions that abut upon it, so that the faculty of extending their range is possessed in a greater degree (Pl. IX, fig. 7).

He also recognises that the ancestral bird life of America, which at the present day is chiefly confined to South America, once occupied the whole Western Hemisphere, but by competition have now a very limited range.

In North America, the Missourian or Central Desert region is equally regarded as a sanctuary or refuge of archaic bird life by Prof. NEWTON, who records that here is found the most undifferentiated and generalised form of American ornithic life, so that it may be considered as the "focus" of Nearctic types.

In **Entomology** little, comparatively, has been done in this direction of philosophical inquiry, and our knowledge of the *internal* structure of insects is so limited, and the considered opinions of those who have studied the subject so few and fragmentary, that material for judgment is very deficient. Nevertheless the few facts that can be gleaned of relative generic dominancy are all strongly confirmatory of the truth of the contentions of this thesis.

In **Lepidoptera**, although Mr. MEYRICK (to whom and to Dr. LONGSTAFF I am greatly indebted for much valuable information) has by his great knowledge worked out with infinite labour a series of probable phylogenies, based upon the external morphology, yet little beyond this has been done to elucidate the phylogenetic sequence of the different families and genera, either as revealed by their internal structure or as indicated by their geographical distribution.

Dr. SHARP has, however, declared that the genus *Vanessa* a group especially characteristic of the Northern Hemisphere, may be considered the *dominant* butterflies of the world, and the most capable of prospering under any varied or adverse conditions to which it may be exposed. This genus in its broad sense contains one species, *Pyrameis cardui*, which is of so adaptable a nature that it is almost world-wide in its range.

The *Nymphalidæ*, to which *Vanessa* belongs, he also regards as the predominant family among the butterflies.

The *Micropterygidæ* are, according to MEYRICK, the primeval

ancestors of all Lepidoptera, and *Palæomicra*, the most archaic genus known, is at the present day restricted to New Zealand, but must at one time have been the most dominant and highly organised of its class, and by parity of reasoning has doubtless arisen in northern latitudes, from whence it has in course of ages been expelled by the more advanced groups that have developed from it.

Many families and genera could be named, as *Libytheidæ*, *Erycinidæ*, etc., which, either from their generalised structure or geographical distribution, may be assumed to be earlier in development than *Vanessa*; but as so little is yet known of their internal organisation, this would be little more than speculative probability.

In **Coleoptera**, the distribution in the British Isles has been studied by Mr. W. E. SHARP, and I am not aware of any similar attempt to group the species geographically and to deal with their universal distribution (Pl. IX, fig. 8).

In his study of the distribution of the British species, Mr. SHARP also aims to demonstrate the sources from which they have been derived, and with the view of showing this origin more clearly, he eliminates all the introduced species which now live under artificial conditions, as in bakeries, etc., and also withdraws all those species which are universally diffused, as affording no help in discovering the *direction* of the immigration.

The remainder he divides into two groups, the *Adaptable* and the *Unadaptable* species. The *Adaptable*, or, as we may term them, the *Dominants*, have their metropolis in this country, in the south-east of England, extending more or less over the whole of the country, but thinning out towards the north and west, and rare or absent in Scotland and Ireland. These are the aggressive group, and are derived from Central Europe.

The *Unadaptable* species embrace three sections, and Mr. SHARP assents to my terming them retreating or decadent.

The first group has a discontinuous distribution, and is restricted to southern and south-eastern England, and Mr. SHARP, as a result of further thought and experience, is now inclined to regard this group as also emanating from Central Europe.

The second group is now restricted chiefly to the elevated moorlands and mountains of Scotland and Ireland, while the third

and last group is a small assemblage of species now confined to Ireland and the extreme south-west of England, and all may be regarded as regressive species.

This distribution is quite or sufficiently similar to that of the mollusca to be satisfactorily explained in the same way.

Even in **Botanical** science, although a connected scheme of the distribution of life has never been constructed or demonstrated, yet it is clear from evidence that can doubtless be adduced that in the opinion of eminent botanists exactly the same principles are in operation as I have demonstrated to exist in animal life.

Mr. BENTHAM describes the plants of the European region as endowed with great powers of dispersal, very prolific, and capable of adapting themselves to a great variety of climatological and physical conditions, with a continuity of distribution that bespeaks a comparatively modern origin. I do not dwell on the opinions of Mr. BENTHAM as to their history (Pl. X, fig. 10).

In corroboration of Mr. BENTHAM's views as to the undoubted dominancy of European plants, we have the declaration of Sir JOSEPH HOOKER that the European flora, being, as pointed out by BENTHAM, of a dominant character, is propagated as a wave of life from Europe to the uttermost ends of the earth, and judging from the number of species cited as existing in a number of places throughout the world, these waves of life would follow the routes along which other organisms travel and have travelled.

The struggle for existence is also as deadly and efficient in plants as in animals, for, as Prof. HENSLOW justly remarks, plants hold their position as long as other more advanced competitors will let them grow. He instances the little Dutch clover, which in New Zealand is driving the huge New Zealand flax before it.

It is also well known that floras now indigenous to Japan or the Himalayas, to Australia and South America, once inhabited Europe, and that groups of wholly different plants successively displace each other, demonstrating that, as with animal life, there is a slow, unceasing migration constantly going on.

In **Man** we have also a full confirmation of exactly the same

course of events as has been more or less fully demonstrated in the various groups of animals and plants: there is (or was before the comparatively modern means of locomotion were devised) the same or similar lines of advance into new territories, and the same deadly results to the weaker races of contact with peoples manifestly superior.

The European or white race of mankind, as in other classes of life, is superior to every other race, being the latest evolved and possessing the most advanced mental development, and is the only race which is multiplying rapidly and extending its dominion over the inferior races (Pl. X, fig. 11).

The Mongolian or yellow race is now sub-dominant only, and is admittedly inferior in intellect, in influence, and dominating power to the European, which is gradually encroaching upon the territories they possess (Pl. IX, fig. 9).

The Negroid or black races are the most ancient people, and are the lowliest and most feeble mentally of the three races. Many tribes and nations have been exterminated by contact with civilised peoples, by wars, and by epidemics, which causes will continue to operate with deadly consequences to these lowly peoples.

The co-ordination of the many facts involved in the dispersal and migration of the human race shows us a very close approximation or identity of principle with that governing other forms of life.

Geological History, or the distribution in time of animal and vegetable life, forcibly displays, as is well known, the operation of the same laws as govern their distribution in space, furnishing by their fossil remains clear evidence, not only of successive evolution of new forms of life, but of the extinction or gradual expulsion from the vicinity of the evolutionary area of the weaker and more primitive previous inhabitants by the more vigorous and later-developed species that have succeeded them, so that, even in a geological sense, the term indigenous or native has no permanent significance.

Having thus shown the sequence of life and its probable place of origin in the mollusca and the earthworms, and indicated that in all other groups the same or strictly analogous processes of regular gradation from the most primitive to the most highly

organised forms of life has taken place, and demonstrated how this succession of life has spread over the earth, the weak in all cases giving place to the strong, it will appeal to you how illogical and unlikely it is that the weak, primitive, and early-developed forms, which have been driven by the competition of improved and stronger organisms to the uttermost ends of the earth, their last foothold prior to their final extinction, can extend their range to the disadvantage of stronger species. Still, this palpable and logical scheme of life may easily be obscured and confused by incorrect or artificial systems of classification, for the many anomalies and absence of order and intelligibility, which formerly existed in the geographical distribution of the *Helicidæ*, were due in a great measure to an imperfect or incorrect knowledge of the true relationship of the component species.

A truly natural classification is thus an essential preliminary to a proper understanding of life-distribution, for this does *not* take place at random, but is in orderly sequence, and imperceptibly passes from the most simple to the most advanced in the scale of life.

The conditions or environment under which life exists have also a great effect in modifying the appearance of living organisms, for its subtle and overwhelming influence moulds more or less perceptibly the form, the habits, and the character of all organised life, and is so universal and pervading that none can possibly escape its modifying powers. The races of mankind are equally subject to its influences, which profoundly affect not only the external morphology but also the mental powers and dispositions of the individual and the race, giving rise to those national characteristics which are distinctive of every well-marked country, and to which any invaders or immigrants gradually approximate.

Viewed in this light, it is difficult to avoid the conclusion that countries of the weakest evolutionary powers, as New Zealand, Australia, South America, and even North America, all countries which have probably never independently evolved any but the lowliest type of life, can never hope to rival, in all that constitutes true progress and intellectual advancement, the European region, from whence practically every form of improved life

has arisen, and the day when these so-called new countries cease to attract the vigorous life of Europe will be the signal for their lagging behind in the race of life and progress.

In conclusion I trust I may be allowed to express the hope that some at least of my hearers will find themselves in sympathy with the lines of thought I have endeavoured to demonstrate, and that their co-operation will materially advance our knowledge of Entomology, a study which in some of its departments is still in the analytical stage and has scarcely yet entered on the synthetical.

The immense numbers of new species that are so unceasingly discovered, and must be examined, described, and classified, leave little opportunity for those so engaged to consider the great principles underlying the study, or to formulate the laws governing its phenomena in the insect world, but there are doubtless some whose inclinations lead them to investigate the laws of nature as exemplified in insects, and it is more especially to them I commend the study of Dominance and its correlation with Evolution, Phylogeny, and Distribution.

EXPLANATION OF PLATES VI—X.

FIG. 1.—Map illustrating the geographical distribution of the *Pentatænia*, the most dominant group of *Helicidæ*, showing their aggregation in and about the chief evolutionary area, which is indicated by the darkest shade.

FIG. 2.—Map illustrating the expulsion of the sub-dominant genera, *Helicigona*, *Helicella*, and *Helicodonta*, from the chief evolutionary region, by their more advanced successors, and showing the initiation of discontinuity of distribution.

FIG. 3.—Geographical distribution of *Helix pomatia*, one of the most dominant species, showing the line of its eastward advance through the area between the southern boundary of the Boreal province of Milachevitch and the northern boundary of the Pontic region of Drouet, which are indicated by shaded lines.

FIG. 4.—Map of the approximate routes of the dispersal of life from the chief evolutionary area in North Central Europe.

The stronger waves broadly indicate the main lines of migration, the finer ripples the relative slowness of the advance.

FIG. 5.—Map of the geographical distribution of the *Helicidæ*, showing the intimate connection of Evolution and Phylogeny with Distribution, and—in connection with Fig. 4—the directions of the migratory streams.

The *Horizontal lines* indicate the area naturally occupied by *Belogona Siphonadenia*, the most advanced group, whose metropolis is in North Central Europe.

The *Circlets* represent the regions occupied by *Belogona Euadenia*, whose centres are now in Eastern Asia and the Pacific coasts of North and Central America.

The *Black dots* show the regions occupied by the *Epiphalllogona*; their centres are now in the Austro-Malayan islands and in the north of South America.

The *Upright lines* indicate the *Prologona*; they are found in Australasia, Africa, the Argentine, and Eastern North America.

The *Sinuate lines* show where the generalised *Haplogona* are still dominant, viz. Antarctica and its vicinity, and the arid central region of North America.

FIG. 6.—Geographical distribution of the Earthworms, illustrating the essential and remarkable harmony of the distribution with their probable phylogeny.

The *Horizontal lines* indicate the natural distributional area of the *Lumbricidæ*.

The *Circlets* that of the sub-dominant *Megascolecidæ*.

The *Black spots* are spread over the regions now chiefly occupied by the *Geoscolecidæ*.

The *Vertical lines* show the countries to which the *Acanthodrilidæ* have retreated and to which they are now restricted.

FIG. 7.—Map of the distribution of the Marsh Titmouse (*Parus palustris*), showing the identity of their route of dispersal with that of other and diverse groups (after RUSSEL WALLACE).

FIG. 8.—Map of the British distribution of *Coleoptera* (after Mr. W. E. SHARP), illustrating its essential agreement with that of other forms of life.

The *Horizontal lines* indicate the area of distribution of the dominant or "Teutonic" species.

The *Circlets* the present range of the regressive "Celtic" or Northern group.

The *Black spots* indicate the areas where representatives of the "Lusitanian" or "Atlantic" group still linger.

The *Black patches* represent the isolated districts where the south and south-western species are found at the present day.

FIG. 9.—Map showing the progress of the expulsion of the Mongols from Europe by the white race, and the route of migration into Asiatic territory of the Europeans (after BERGHAUS).

The *Black area* shows the regions dominated by the white race

and also the line of their advance through Asia, which is exactly that of the Molluscs, Birds, etc.

The *Diagonal lines* represent the territory still occupied by the Mongolians.

FIG. 10.—Map showing the European distribution of the flowering plants, and displaying the identity of their routes of dispersal with that of other plants and animals (after Prof. DRUDE).

The *Black area* indicates the regions now occupied by the dominant flora of North Central Europe, which is advancing east by the same route as that travelled by animal life.

The *Diagonal lines* represent the " West Siberian " flora, which is in process of expulsion by the North Central European flora.

The weaker Mediterranean type is shown by *oppositely drawn Diagonal lines*, and the *Vertical lines* indicate a more feeble extension through Asia Minor. The *Horizontal lines* represent the Central Asiatic flora.

FIG. 11.—Map showing the relative geographical positions of the European or white races and the Mongolian or yellow races in the fifteenth century (slightly modified after HAECKEL).

The *Black area* indicates the area occupied by the European or white race, and shows their eastward progress to be by precisely the same route as that followed by all other forms of life.

The *Diagonal lines* show the region then dominated by the Mongol tribes.

SOME EXPERIMENTS ON THE REGENERATION OF
THE LEGS OF *LIPARIS DISPAR* L. (LEPIDOPTERA).

By T. A. CHAPMAN, M.D., REIGATE.

(Plates XVI—XXV.)

My object in the first instance was to determine which larval joints in the legs corresponded to those of the imago, and it soon was obvious that the basal plates represented the coxa and trochanter, whilst the three marked divisions of the larval leg were femur, tibia, and tarsus.

It became also obvious that complete regeneration could not take place in one moult, but that several were necessary to complete regeneration, and that this was not really complete, if size were taken into consideration, unless the moults were numerous.

This must, however, be taken as referring to the chief subject of my experiments, *Liparis dispar*, as in *Agrotis pronuba* the process was much more rapid.

The wounds made in the experiments never seemed to take on any septic action, except in a few cases, when the larvæ were kept too damp, when the crust over the wound became mouldy and the larvæ died. Nevertheless, the crust did not always seem to be a mere superficial crust, but seemed to involve some of the tissues, possibly due to too dry an atmosphere; but the result was that the lost parts seemed sometimes to amount to more than were actually amputated.

My first experiments were made more than a dozen years ago, and I have made others since, and I have some four hundred preparations of the same character as the selection from them presented in the photographs.

Damage, generally amputation, was done to one leg of a larva, one of the third pair being selected, in order that any malformation of the pupal integument should not interfere with the final rearing of the specimen. I found later that this precaution was unnecessary, and that one of the first or second

pair could equally be experimented on, and afforded some record of the condition of the appendage in the pupa.

I began by chloroforming my larvæ, before injuring them, but found that the chloroform inconvenienced them vastly more than the operation, so that such an effort to make the operation painless was worse than useless. I believe the larvæ experience no pain as we regard it, but I found that anæsthesia was an advantage in handling the larvæ, and that this could be secured, without damage or serious inconvenience to the larvæ, by drowning. If only reduced to complete anæsthesia, they very rapidly recovered without any apparent ill effect.

As regards pain, the response to outside agencies is developed as pain in the higher vertebrates to guard the animal against local injury, but in these larvæ (and in most insects) local injury is of little comparative moment, and seems hardly to be felt, whereas capture, with a view to being devoured, is a very common accident, and so any interference, suggesting or amounting to capture, produces very grave discomfort and corresponding efforts to escape; and so in handling my larvæ without anæsthetics, the struggling was great, and the muscular efforts caused the wounds made to bleed, though the actual operation performed produced little reaction.

The anæsthesia of partial drowning overcame both these difficulties. That of chloroform was generally accompanied by profuse eructations of fluid, and the recovery was usually slow, with debility, due to the vomiting, much in excess of anything caused by the operation.

The photographs (by Mr. F. N. CLARK) show the imaginal legs, usually of both sides for comparison, and the larval legs of each moult, from the instar in which the injury occurred onwards, and in some cases the pupal coverings. These are all magnified $7\frac{1}{2}$ times, except where a \times is placed against the photograph—these are magnified 15 times, twice the amplitude of the others. A few have other magnifications, generally $\times 20$: these are recorded on the photograph.¹

In comparing the specimens, this difference must be remem-

¹ The plates are fractionally reduced from the photographs; exceptionally Plates XVIII and XXIII are reduced nearly as 4 to 3. The relative dimensions of the items in the plates are of course unaffected by this.

bered, else it might appear that the earlier instars are larger than the later. In some of the cases the specimens have been reversed, so that a left leg is on the right side, or vice versa.

The leg operated on was generally the left of the third pair; these give no pupal record. When a leg of the first or second pair is treated, its condition leaves a record in the pupa.

The photographs of the larval legs are from the cast skins mounted in Canada balsam. In some cases a skin got lost, in others it was broken or injured, and in some it proved difficult to unravel from a shrivelled-up cast skin, and had to be mounted in an unsatisfactory way, in case it should be broken by further manipulation. Some of the illustrative specimens selected for photographing have some of these defects, but are such as show what is desired, and as are characteristic of the group of specimens to which they belong.

Last Larval Instar: Tarsal Joint removed.—In fourteen specimens, in eight of which the tarsal joint was partially and in six wholly removed, the tarsus of the imago was normal.

In nine other specimens the tarsal joint was completely removed in five, and in four others the cicatricial tissue appeared to infringe on the tibial joint. How far this is so is necessarily more or less doubtful in this and other groups.

In the first five there is complete regeneration in one case. In two others the new tarsus is of reduced size, but otherwise normal. In one there are only three tarsal joints of approximately normal size. The fifth of these has three tarsal joints, of a length equal to two normal (proximal) joints, but a rounded nodule represents the last two joints. This specimen is remarkable as having no claws, which are almost invariably present, no matter how reduced the other elements of the limb are.

In the four specimens with certainly the whole tarsus, possibly some of the tibia removed, one has a tarsus normal, except that it is only 3 mm. long instead of a normal 4.3 mm.; one has a single-jointed tarsus (fig. 6); two have a single-jointed tarsus, but with the claws at some distance from the extremity (fig. 8).

Last Larval Instar: more or less of Tibia removed.—Of these there are twenty-three specimens. One of these wants the

whole leg in imago; some crushing or septic process must in this case have affected the femur. Another has deformity of the femur and has no claws, but the pupal covers show some damage to the pupa, possibly by the crust over injury during ecdysis.

The remainder may be divided into *five* specimens with a merely nominal tarsal joint, *ten* with one tarsal joint, *two* with two tarsal joints, *three* with three tarsal joints, and *one* with four, none with a complete tarsus (figs. 3, 4, 5, 7, 12).

Those with a merely nominal tarsus have the tibia slightly shortened, and in one a little clubbed. The ten with one tarsal joint show one tibia shortened, four others rather clubbed (one of these slightly longer than normal), and five with practically normal tibiae. Those with two or more tarsal joints have normal tibiae.

One of the group with nominal tarsus has no claws; the remainder all have them, and more, perhaps, in this set (damage or removal of tibial joint) than any others have branched and deformed claws (as in figs. 3, 6, 7, 12).

Last Larval Instar: Femur more or less removed.—Of these are twenty-one specimens (figs. 2, 9, 11). One has nodules probably representing trochanter and femur, but not extending so far as coxa of other side; this specimen had probably some additional damage (septic?), as the whole femur was not removed.

In *five* specimens with the whole femur removed, one has a rudimentary femur, nodular tibia, and a little mass that may be called tarsus but looks like a number of claws fused together, there being visible five tips of claws.

Another much the same has two double or triple jointed claws at the end of what is a small tibio-tarsal mass. Another has a diminished trochanter, a spherical minute femur with a projecting point as claw. The fourth has a small trochanter and a small, rounded mass with claw-points. The fifth is similar.

Three with the femur not so completely removed show results in the imago of much the same character.

There are *twelve* where the amputation is through the femur, leaving a portion. In all these the imagines have some femur, and in seven instances it is of more than half the normal length, and in five of these only a little reduced. Seven have also tibiae of normal structure, though of reduced size; the others

have small portions without spines or otherwise defective. As to tarsi, two have only a trace, yet with points representing claws; three have merely claws at end of tibial piece; three have one tarsal joint; three have two and one has four.

Last Larval Instar: some basal parts removed—that is, some portions representing coxa and trochanter. Of these there are thirty-two examples, though the cicatricial crust renders it difficult to say in many instances whether the specimen belongs to this or the preceding group (femur removed) (figs. 1, 13).

In the imagines it is obvious, however, that the trochanter, and usually the coxa also, has been interfered with. In a few the coxa is almost absent, in others it is reduced. In others there are nodules that represent trochanter and other parts individually indistinguishable except that in seven instances actual claws exist on the nodules.

Penultimate (fourth) Instar (two skins preserved), fifty-one specimens. *Tarsus more or less removed*, six specimens.—In four of these the tarsus is normal, in two it is slightly shorter than normal—3·7 mm. instead of 4·3, and 3·5 instead of 4·5—but otherwise normal.

The Tibia wholly or partially removed, in twelve specimens.—In all these the tarsus is a little reduced in size, but otherwise normal except in two, in which the third and fourth joints are ankylosed but distinguishable, and one (when the femur seems, however, to have also been injured) where the tarsus consists of only three slender joints. In these three and two others the tibia is slightly reduced in size or thickened; in the other seven it is practically normal.

The Femur more or less removed, twelve specimens.—In four femur, tibia, and tarsus are normal, but all reduced in size (fig. 10); in two of these the whole of the femur appears to have been removed. There are *three* with the tarsus reduced to four joints, in two with appearance of the reduction being the result of third and fourth joints coalescing; in these the femur and tibia are both much reduced; in none of these three was the whole of the femur quite removed. In the remaining *five*, there are two, three, or four tarsal joints (fig. 21), the count being difficult, owing to more or less ankylosis. In all of them the femur and tibia are much reduced and a little deformed.

The claws are normal in two, a little deformed in one, and in the other two are fused and deformed, but with two points.

In twenty-one specimens *the femur* appears to be *totally removed*, and the base more or less interfered with (figs. 22-24).

In three of these there is an apology for a normal leg. One of these has a coxa slightly abbreviated, a reduced trochanter, a femur and tibia each about 1 mm. instead of 5 mm., and a tarsus of about the same length, of one joint, with traces of division into three or four; and two nearly normal claws. Another has normal trochanter, femur 2 mm. instead of 4, and a tibia and tarsus not too distinctly divided, of same length, and two good claws. The third has a femur little more than half normal length, a tibia of about 1 mm., and a tarsus consisting of a club about 1 mm. long, with a terminal circular pit, and another at half its length; within the latter are two nearly normal claws, and something like another in the terminal pit.

The remainder present seven in which there is no trace of leg except a slight nodule in three cases, one of these showing one claw; seven in which there is a femur, and a conjoined tibia and tarsus each not far from 1 mm. in length; four have claws, in one case buried in a cavity; one hardly belongs to this section, as it has a five-jointed tarsus of some length (1.1 mm.) but quite filamentous with claws; the tibia is only 0.5 mm. long, and very deformed. The remaining four differ only in having, as well as a minute femur, a mere nodule to represent tibio-tarsus, but two of these have claws, and a third a rudiment of one.

Third (antepenultimate) Instar (three skins preserved).—There *may* be a question as to whether third instar is always correct for these, as, though the rule is four moults (and a fifth to pupa), *i.e.* five instars, I think there is occasionally another, making five moults and six instars.

I do not find amongst my preparations any in which only the tarsus or tarsus and tibia were removed, but the actual results show that it is fairly certain that such removals would have been followed by complete regeneration, with, in some cases, some reduction in size.

Femur more or less completely removed (fig. 18).—Of these there are *fourteen*. It may be again observed that it is here more difficult to say precisely how much was removed, owing

to the small size of the larvæ operated on, and the obscurity due to the cicatricial crust. Of these fourteen, in seven the regeneration is complete except as regards size, one of the seven being all but of full size, ranging down to the smallest, with the limb (all the joints) of about half the normal length. In three specimens the femur is of almost normal length, in all the tibia is markedly reduced. In three at least of these six the femur was completely removed.

The remaining seven may in some cases have sustained some injury to basal portions, either by operation or after repair. In all cases there is present a limb, of about half normal size, in one (or two) cases distinctly less than this. There is always a femur and tibia, without marked distinctions except a little clubbing of tibia in two cases. None of these, however, has a complete tarsus. It consists of two, three, or four joints, short and thickened, or dwindling and filamentous. Three specimens might be said to have five joints if ankylosis be disregarded. All have claws (except one damaged specimen), in two cases deformed.

Basal parts interfered with (figs. 19, 25, 28), sixteen specimens.—Of these, *two* have no trochanter, *one* has trochanter only; *three* have a nodule representing femur, etc.—one of these has something by way of claws (fig. 14), and the other two, sufficiently magnified, show trochanter, femur, tibio-tarsus (one piece), and good claws (fig. 16), the whole doubled up, and about 1.5 mm. long if straightened out. *Five* have obvious legs with femora 2 to 3 mm. long and tarsi with one joint in four cases and two in the fifth. They all have claws, in one case in a pocket (fig. 17), in another bifid. *Five* possess four-jointed tarsi: in two the limb is of good size (fig. 18), in the others the femur is 2 to 4 mm. long.

Second Instar (four skins preserved).—Of these in only *two* (fig. 26) was the injury to the tibia only. In these the larval leg was complete, but a little short in the last instar, and in the imago the limb was reduced too little to be noticed without measurement. In nineteen the femur was wholly or partially removed. In all of these the imaginal limb is complete with five-jointed tarsi. In five the limb is visibly but not much reduced in size; in the other fourteen, it is of full size or appre

ciably so. In no case is the larval leg of the last instar of full size, but it usually has a small claw.

There are *eighteen* in which the *basal parts* are more or less implicated in the amputation (figs. 27, 29). Of these five have only four tarsal joints, and all of these have the leg very rudimentary in the last larval instar, less than a fourth of the normal femur in size. Thirteen have the legs complete with five-jointed tarsi, three or four of practically normal size, the rest somewhat reduced but none very small; the leg in the last larval instar is usually complete, but generally rather smaller than the normal femurs. In the two intermediate instars it often seems absent or represented by a not definitely namable chitinous plate.

First Instar (five skins preserved) (fig. 33).—There are two such specimens in which the whole leg and some of the base appears to have been removed. In one of these the third instar presents the basal plates of small size, and the leg as a chitinous shield; in the fourth instar, the leg has three joints, but is only as long as the opposite femur. In the last instar the leg is about half the normal length, and a little deformed; the imago appears normal. In the other specimen the leg appears as a small shield in the fourth instar, one later than in the other specimen, and is not so well developed in the last instar; the imaginal leg is visibly shorter than the other femur, being 4.5 mm. against 5, tibia nearly normal, tarsus 3 mm. instead of 5 mm.

There are some specimens that do not quite admit of being classified with those so far noticed. For example, fig. 20 shows a specimen in which amputation in the third instar was intended, but resulted only in some basal injury to the leg. The third instar preparation does not show the injured leg; the fourth instar shows it present, but curiously deformed; the fifth shows the deformity to persist, but exaggerated in the preparation by twisting having occurred at the weak zone—the imaginal result is a nearly normal tarsus, but very deformed femur and tibia, with an attempt to produce two supernumerary legs at the femoro-tibial articulation, both very minute, but one with several joints.

Fig. 15 illustrates a very similar specimen in which the third instar skin is not photographed.

There is a specimen in which the injury in the third instar is represented by a crust across the basal parts, but in the fourth, fifth, and the imago, there is nothing to note except reduced size. Another specimen is similar, but that the leg is much reduced in the fourth and fifth instars, with abbreviation of the tibia and tarsus as in ordinary regeneration, and but little diminution in size in the imago. In another similar specimen the fifth instar is very much like specimens where regeneration is complete, but the imago has the femur, tibia, and tarsus of little more than half the normal length.

Another specimen, with a less severe injury in the second instar, shows considerable reduction in size in the fourth instar, very little in the fifth, and an imago with a barely appreciable reduction in size.

Related to these last noted specimens, are some sixty-four preparations, in which the larval leg, generally in the last instar, was more or less crushed, without actual wound.

In twenty-six of these the injury has had little or no result, the imaginal legs being perfect, and with trifling reduction of size in two or three instances. In thirty-three, on the other hand, the leg is either wanting or much reduced, in the remainder there is a reduction in the number of tarsal joints in an otherwise more or less well-developed leg.

Amongst these specimens are twelve that show more or less duplication of parts. Omitting the twenty-six examples in which the supposed injury did not, in fact, take place, these duplications are twelve in thirty-eight, or over 30 per cent.

Amongst the amputations only one (fig. 23) shows anything that resembles duplication, and in this there is only an excess of claws, which is not very unusual, and can hardly be called duplication, as it seems to be a result of the very strong determination there seems to be that the claws shall be reproduced, no matter how primitive the other parts may be.

As the duplications observed were the result of operations on the last larval instar, it is probable that duplications of a more organised character, and more like a portion of an ordinary limb, would result from experiments in earlier instars.

Some of the more marked of these specimens are represented in figs. 30, 31, 32, 34, 35, 36, 37, 38, 39, and 40.

Figs. 38, 39, and 40 suggest how crushing results in such duplications.

One of the most remarkable observations I have made is that in sixty-nine damaged legs of *Agrotis pronuba* larvæ, sometimes six in one individual, occurring naturally (?) and accidentally by the larvæ biting each other, I believe, resulted in not one observable result in the imagines, whose limbs were all perfect and of full size, yet the injuries were identical with those that left very marked deficiencies in the imagines of *L. dispar*.

In *S. fagi* and *S. carpini* some half-dozen specimens showed similar results to those in *L. dispar*.

I have preserved the parts illustrating eleven experiments on the antennæ of *Ennomos autumnaria* and nine of *Saturnia carpini*. These show various defects in the imagines, but the larval antennæ are too small to handle with precision, and the preparations of the larval cast heads are not easy to interpret owing to the crusts formed, so that beyond the few facts that the imaginal antennæ may be wanting, variously defective, or all but normal, there is nothing that I have learned from these experiments.

There are some dozens of specimens, in which, due to various accidents, the records are imperfect, and none of these appear to show any effects that under this condition require comment.

The general conclusions I draw from these experiments are that unless a very radical removal of the leg be made, regeneration always takes place, that regeneration of the whole leg takes place when the femur and part of the trochanter and even coxa are removed, if four or five further moults have to take place, but regeneration is less perfect the fewer the following instars, and more perfect the fewer the number of the joints removed. The variation of the results in different instances of the same injury at the same stage may be due, to some extent, to different vital stamina in the individuals, but more probably to different tissue accompanying the operation, or to some slight septic action causing a weakening of the tissues involved and consequent slowness to undergo development.

There was always some effort at regeneration, but if there were too few moults, one only, for instance, after the injury, some defect always resulted. The only exception to this is

where only a portion of the tarsus was removed, in several of which there appeared to be no defect in the imago. These exceptions are, no doubt, correlated with the determination there seems to be that, whatever happens, the claws and some of the last tarsal joint shall be reproduced, and claws are consequently found on most rudimentary limbs that are merely nodules.

Though the strong tendency of the claws to be reproduced probably modifies the result, there seems reason to believe that the regeneration is more perfect in the case of the part injured than in more distal ones. An injury to the femur, for example, results in the femur being more completely reproduced than the tibia and tarsus, the latter being much less complete than when the tarsus alone had been removed at the same larval stage.

Another conclusion is that when there is amputation by a clean incision, regeneration takes a simple and straightforward course, but where crushing takes place, and possibly therefore division of the group of embryonal cells that provides for regeneration, there may take place various supplementary portions, branches, and duplication of limbs. All my experiments of this character were made in late (usually last) instars, and consequently the supplementary parts only developed in the crude way that equally occurred, in such instars, in cases of amputation, in the development of the limb itself.

A comparison of the results in *Agrotis pronuba* and *Liparis dispar* shows that the rapidity of regeneration is very much greater in some species than others.

SOME ENTOMOLOGICAL PROBLEMS IN THE WEST INDIES.

By H. A. BALLOU, M.Sc., Entomologist on the Staff of
the Imperial Department of Agriculture.

SINCE 1898 the Imperial Department of Agriculture has been closely associated with the agricultural work in the West Indies. The expression West Indies in this connection refers to the islands comprised in the Windward and Leeward groups and Barbados, for it has been in these islands that the Department has exercised its advisory functions to the greatest extent. The larger colonies, Jamaica, Trinidad, and British Guiana, have never been closely associated with the Department, but it has always been possible for them to seek and obtain advice on all agricultural matters. Since the end of 1899, the Imperial Department has numbered on its staff an Entomologist, whose duties have included investigation of and advising upon insect attacks on crops and domestic animals!.*

It may be of interest at this time to outline briefly a few of the matters which have come before the Entomologist for consideration, with special reference to those which are unique in character, as are a few of the West Indian entomological problems.

SUGAR CANE.

Moth Borer and Weevil Borer.

At the time of the formation of the Imperial Department of Agriculture the critical condition of the sugar industry was the chief concern to those who had the agricultural prosperity of the West Indies at heart. In this connection the principal problem to occupy the attention of the Entomologist was that in connection with the control of the moth borer (*Diatraea*

* See end of Article for notes.

saccharalis Fabr.). Valuable work on this subject was done by Mr. MAXWELL-LEFROY and published in *West Indian Bulletin*, vol. i., p. 327²; the weevil borer (*Sphenophorus sericeus* Oliv.) also received its share of attention, and an account of this insect was published in *West Indian Bulletin*, vol. iii., p. 88.³ These two pests, and several others, whose attacks are only to be considered as secondary in importance, are similar to pests which occur in other parts of the world.

The so-called root borer (*Diaprepes abbreviatus*), and the white ants or termites attacking growing canes in the field, are problems which present themselves for solution in the West Indies, and so far as known occur nowhere else.

Brown Hard-back.

Entomologists, generally, will be aware of the serious attacks of a Lamellicorn beetle in the sugar-cane fields of certain districts in Mauritius.⁴ This insect, which is now to be known as *Phytalus smithi* Arrow, occurs also in Barbados, where it cannot be said, however, at the present time to be a pest of sugar cane or indeed of any crop; but it is known to occur in sugar-cane fields and in garden beds, tubs, and other receptacles in which ornamental plants are growing. This occurrence presents features of very considerable entomological interest, since it is likely that here we have one or other of two conditions. One has reference to the fact that *Phytalus smithi* may be a native of the West Indies, especially of Barbados, and is being kept in check by efficient natural enemies.* Closely connected with this hypothesis must be recognised the probability that in Mauritius the insect, being a recently introduced form, is not accompanied by its natural enemies, and consequently has developed in the most remarkable and alarming manner. When it is remembered that in the endeavour to attain a degree of control over this insect in Mauritius, by the capture of the

* While this paper was in course of preparation, a letter appeared in the Barbados papers to the effect that Mr. NOWELL, Assistant Superintendent of Agriculture of the Local Department, has discovered a parasite of *P. smithi* in sugar-cane fields in that island. The parasite has been identified as *Tiphia parallela* Smith.

adult beetles as they emerged from the soil, more than 25 millions of these insects were collected and destroyed during the two months November and December 1911, and that in one night the catch amounted to nearly three million, it will be seen that it is not too much to say that the numbers are both remarkable and alarming. It might be added that this insect has been sufficiently numerous in Mauritius to attract attention only during the past year or a little more, and that the infested area is only about 600 acres in extent. The other condition called to mind by the occurrence of *Phytalus smithi* in Barbados rests upon the hypothesis that it may be a recent introduction into that island, and is on the increase, and may eventually assume something of the serious proportions to which it has attained in Mauritius. As bearing on this point, however, it may be remarked that specimens of this insect collected in the West Indies some years ago are stated to be in the collections of the British Museum; but on the other hand it should be borne in mind that it is only during the past two or three years that this insect has occurred in sufficient numbers in Barbados to attract any attention at all. In June 1910, in two localities in the vicinity of Bridgetown, this insect, which is known locally as the brown hard-back, made its appearance in gardens or ornamental grounds in very considerable numbers. In one place something over a pint of these insects was collected in a small garden in the early morning, when they were found hanging on the foliage of roses and other plants.

Root Borer.

The root borer of sugar-cane (*Diaprepes abbreviatus* Linn.) is also a pest found in Barbados, restricted to a very small district, where it has caused a very considerable amount of injury and given rise to grave apprehensions as to what will happen if it extends its attacks to other parts of the island. A general account of this insect was published by the Rev. N. B. WATSON, F.E.S., in the *West Indian Bulletin*, vol. iv., p. 37. Although this account was based on investigations carried out during 1899-1901, when the insect was studied purely as a matter of general interest, it was not until 1910

that it was recognised as a pest of importance.⁵ *Diaprepes abbreviatus* had been for many years a well-known insect in its adult condition. It was called locally the lady-bird, and seems to have been very generally familiar to the children, who captured it, admiring its bright colours of varying shades of green, orange-yellow, and black, and then sent it on its way to the words of the old couplet, "Lady-bird, lady-bird, fly away home," etc. As indicating the increase in numbers which this insect has shown, it may be stated that in June and July 1911 some twenty to twenty-five thousand of the adult beetles were captured on one estate, where the area seriously attacked by the root-boring grubs was probably not more than 40 or 50 acres in extent, and that in the immediate neighbourhood the collections on four or five estates (some 600 to 800 acres) totalled something like sixty thousand. At the end of June and the beginning of July 1912, these insects were making their appearance again and were being captured in considerable numbers. The manner of the attack of these insects is rather interesting. The eggs have not been found in the field, but from observation made on insects in captivity it is believed that the eggs are laid upon the leaves of the cane or other plants, upon the roots of which the grubs will feed. As the eggs hatch, the grubs drop to the ground and immediately make their way into the soil, where it is believed that for several months they feed upon very small roots. Later, the nearly full-grown grubs tunnel into the underground portions of the stem of the sugar-cane, completely eating out the interior, and, in the case of severe attack, the supply of moisture from the fibrous roots to the above-ground portions of the plant is entirely cut off. It happens that this aspect of the attack occurs just at the season of year when the canes are ripening, and when the rains are ceasing, so that, with the injury to the circulation of the plant, the demands for moisture made by the ripening canes, and the absence of rain, the attack by root borer becomes apparent with a suddenness that is somewhat appalling.

Attacks of a root borer have been observed in a few instances in St. Kitts, and in one or, possibly, two instances in Antigua. These are known only from the appearance, in underground portions of the cane, of grubs similar in appearance to the grubs

of *Diaprepes*. The adult is not known ; a greyish weevil smaller in size than *Diaprepes* has, however, been found a number of times in the soil in close proximity to infested cane stumps, in such a manner as to suggest a relationship between it and the grub.

These appear to be the only localities where attacks have occurred in the underground portions of the sugar cane by insects of this kind, that is, by the larvæ of the larger weevils.

Termites.

For several years past, termites have been recognised as a serious pest in sugar cane in the island of St. Kitts.⁶ In 1906 these insects were so abundant in two or three fields on one estate as to cause almost complete loss of the sugar-cane crop over an area of some 25 to 30 acres, *i.e.* a money loss of from £350 to £400. The fields in which this attack occurred were planted in cotton for two or three years, and then the land was returned to sugar cane. Up to the present time, 1912, no serious attack of termites has occurred on the areas where cotton was planted ; but these insects have caused a considerable amount of damage in the immediately adjoining fields. A severe attack of a fungal root disease and unfavourable weather conditions, especially extreme drought, seem greatly to influence the abundance of these insects. The species concerned has not been definitely determined, but it is believed to be *Termes flavipes*. No nests of these termites have been found in or near the fields attacked, and no royal queens have been discovered. In one field, breeding galleries, which are slightly enlarged tunnels containing a few complemental queens, have been discovered, and it is believed that these are the breeding-places in which the propagation of the species takes place. Winged individuals, soldiers, workers, and complemental queens are now known. Larvæ have not been discovered in numbers, and it is therefore believed that there must be galleries, of a kind not yet discovered, in which the young are fed and developed.

The same species of termites has been found attacking the woodwork of buildings in St. Kitts, and it is probable that this is the species which is most concerned in the destruction of

buildings and timber used generally in construction work in the West Indies. Other species are, however, sometimes found in these situations, and it is of interest that not many yards distant from canes badly infested with termites there stands an old disused house the woodwork of which has been badly injured by termites, but the only specimens which could be obtained in the house were of a species quite distinct from that present in the field. As the galleries in which the egg-laying females have been found are within some 10 or 12 inches of the surface of the ground, it is likely that thorough cultivation will be found a fairly efficient means of control, especially when such cultivation is practised in connection with a careful rotation of crops and the planting of a crop like cotton, which is not subject to the attacks of these insects.

It often happens that sugar-cane cuttings used for planting are attacked in the field by termites, and it is known that more than one species is concerned in such attacks. On this one estate in St. Kitts, however, we have the only recorded occurrence of termites attacking ripening canes, canes in which a considerable amount of growth has taken place, which they injure by eating out the entire interior of the stems as the sugar begins to form in the internodes.

COTTON.

After a lapse of many years, during which time there was no cultivation of cotton in the West Indies as a whole, the cultivation of this crop was taken up very generally throughout these small islands in 1902 and 1903. The Imperial Department of Agriculture has offered valuable assistance in this direction. Cotton growers have had to combat several insect pests, among them the well-known cotton worm (*Alabama argillacea* Hübn.). There have also appeared several pests which are entirely new as pests, and in fact were new to science. The flower-bud maggot (*Contarinia gossypii* Felt), the red maggot (*Porricondyla gossypii* Coquielett), and the leaf-blister mite (*Eriophyes gossypii* Banks) being the most important of these, while the black scale (*Saissetia nigra* Nietn.), which was known to occur on a variety of plants throughout the West Indies, assumed serious proportions as

a pest of cotton when large areas of this crop began to be cultivated. This insect will be referred to at another place in this paper.

The Red Maggot.

The red maggot occurred in Barbados as a pest of some importance during two or three seasons shortly after the cotton industry was taken up. More recently very little has been heard of it as a pest. The injuries due to this insect result from the feeding of the larvæ in the cambium layer of the stems of the plants, where they cause the bark and wood to die, which often results in the death of the plant.⁷

The Flower-bud Maggot.

The flower-bud maggot caused very serious losses to cotton growers in Antigua during the seasons 1907-8 and 1908-9. As a consequence of this loss the areas planted in cotton in that island have been reduced; many estates in those districts where the attacks were most serious having abandoned cotton cultivation entirely. This insect injures cotton by causing the flower-buds to fall soon after they are formed. The female parent deposits eggs in the tissues of very young buds, apparently with the object of placing them as near the essential organs of the flower as possible, in order that the larvæ may be in the best position to feed upon their rich food. It is obvious that the loss of from 50 to 90 per cent. of the flowers or flower-buds will have a very serious effect in reducing the yield. The loss in certain fields in Antigua has been as great as indicated by these figures.

The flower-bud maggot occurs only at certain seasons, and as the time of its appearance is rather late, it is possible in many districts to procure a profitable crop before the attack of the pest commences, and in seasons when early planting is made possible by early rains, these estates have found that a fair crop of cotton can be grown.⁸

The flower-bud maggot has made its appearance in Montserrat, where its distribution is fairly general over most of the island, but no serious injury from its attacks has yet been

reported. This is probably due to the fact that in Montserrat it is usually possible to plant early in the year (May or June), and the crop is thus assured before the time of the attack of this pest (November and December).

Leaf-blister Mite.

The leaf-blister mite made its appearance as a pest of cotton almost as soon as the attempt was made to re-establish the cotton industry.⁹ It was first noticed in Montserrat, but was found very shortly after to occur in all the islands where cotton was grown, with the exception of Barbados, in which island its appearance was not recorded until the beginning of the present year (1912), although it is likely that it had occurred for several years in certain districts on the leeward side of the island without having been discovered.¹⁰

The leaf-blister mite injures cotton by causing such deformities of the leaves, flowers, and bolls as to interfere seriously in the performance of their normal functions, and these attacks often result in the death of the plant. The attack is made in the bud, the leaves being more or less deformed, according to the severity of the attack, when they first unfold. Late in the season the attacks of leaf-blister mite in the axillary buds prevent the development of secondary lateral shoots, thus interfering with the production of what is known in the West Indies as a second picking. It follows from this that when leaf-blister mite is present in a cotton-growing district, it will be possible to produce cotton profitably only when the entire crop can be produced in the first picking. If this can be done, and if infested leaves are picked off and destroyed as soon as they appear on the young cotton plants, and the method is practised of destroying by burning all old cotton plants as soon as the first picking is finished, say in February in each year, cotton can still be grown at a profit in spite of the presence of the leaf-blister mite.

INSECTS AND THEIR NATURAL ENEMIES.

The control of insect pests by their natural enemies is a feature of entomological work which at the present time is attracting a very considerable amount of attention on account

of the very large scale on which trials of this interesting work are being carried out in various parts of the world. In the West Indies, there are several very good instances of the efficiency of natural enemies in controlling insects which, without their influence, would become pests of importance.

The black scale of cotton has already been mentioned as having been a serious pest in Barbados a few years ago. The very complete control which was assumed over this pest by its parasite, a small hymenopterous insect to which the name *Zalophothrix mirum* Crawford,¹¹ was given, resulted in almost entirely freeing the cotton crop from attacks by this pest. That is to say, the black scale was so quickly overcome by its parasite on its appearance in the cotton fields in Barbados, that for the past five or six years there has been practically no loss occasioned by the attacks of this insect in this island. In other cotton-growing islands, however, this parasite has not controlled the black scale so completely as in Barbados, but its influence has without doubt been very beneficial.

For a number of years the question of black blight in Grenada was considered to be very serious.¹² Many trees, especially mangoes and others, which were nearly always infested to a certain extent by scale insects, were seen to be covered with the black blight or sooty mould, a black fungus of the genus *Capnodium*, which is nearly always found to be associated with the occurrence of scale insects.

About three years ago the study of the entomogenous fungi in the West Indies was undertaken by Mr. SOUTH, who published a paper on the Control of Scale Insects in the British West Indies by means of fungoid parasites, in the *West Indian Bulletin*, vol. xi, p. 1.¹³ As a result of this study the agricultural officers in Grenada began to devote their attention seriously to the use, under control, of the shield-scale fungus (*Cephalosporium lecanii*). Scale insect material bearing this fungus was distributed in different parts of the island where black blight occurred abundantly, and it is now reported by the Agricultural Superintendent that the decrease of scale insects and black blight in Grenada has been very marked. In Dominica there is a very considerable cultivation of citrus fruits, especially limes, and in that island several of the pests of these trees occur. It

is only rarely, however, that any of the scale insect pests of citrus plants there become numerous enough to require spraying or other remedial treatment, and this is due to the presence, under suitable conditions, of the natural enemies which are able to keep these pests within bounds.

The purple scale (*Lepidosaphes beckii* Newman), the white scale (*Chionaspis citri* Comstock), and the green scale (*Coccus viridis* Green) are the principal scale insect pests of citrus plants. These of course are attacked to a considerable extent by parasitic and predaceous insects, but it seems likely at the present time that the completeness of their control is more largely due to the activity of the red-headed fungus (*Sphaerostilbe coccophila* Tul.), white-headed fungus (*Ophionectria coccicola* E. and E.), and the shield scale fungus (*Cephalosporium lecanii* Zimmermann). The belief that the parasitic fungi are the more efficient organisms in the control of scale insects in Dominica is based on the fact that in that island the climatic conditions are generally very favourable to the development of fungi, and as a result the natural control of scale insects is fairly complete. In those islands possessing a drier climate the fungi have less favourable opportunities for growth and development, and the control by natural enemies is much less complete, even though parasitic insects may occur to the same or even to a greater extent than in Dominica. In wet seasons and in damp situations, however, instances have been found, even in the dry islands, of fairly complete control of scale insects by these parasitic fungi.

Another very interesting example of complete control is to be found in the case of the cotton worm (*Alabama argillacea*) in St. Vincent.¹¹ During the past ten years a very considerable area has been planted in cotton in St. Vincent, and although the cotton worm has been known to be present in that island for the greater part of that time, there is no record of its ever having become numerous enough to cause any loss to cotton planters or serious injury to cotton plants. This is rather remarkable, since in the adjoining small islands of the Grenadines and in St. Lucia, where cotton has been grown on only a comparatively small scale, the cotton worm has appeared as a serious pest.

The insects which appear to be responsible chiefly for the

control of the cotton worm in St. Vincent are the Jack Spaniard (*Polistes annularis* Linn.), an internal parasite (probably *Chalcis annulatus* Fabr.), and the fiery ground beetle, *Calosoma caldium* Fabr. The most beneficial of these insects is, without doubt, the Jack Spaniard, which is predaceous on the larvæ or "worm" stage of *Alabama argillacea*. This insect, which is known in Barbados as the wild bee, is recognised in that island also as a very efficient enemy of the cotton worm.

The natural enemies of the cotton worm¹⁴ are sufficiently abundant throughout the West Indies, so that this troublesome pest is, in certain years, held in check to such an extent as to be comparatively insignificant in the damage it does; on the other hand, in certain years and at certain seasons, it occurs in extreme abundance, the waves of relative abundance and relative scarcity following each other in the manner usual in the case of insects which are controlled by natural enemies.

REFERENCES.

The following list of references includes a few of those in the *West Indian Bulletin* and the *Agricultural News*, which apply to the points contained in the foregoing paper. Many other references to the same subjects are to be found in these publications. A general reference is hereby made to the Handbook entitled *Insect Pests of the Lesser Antilles*, by H. A. BALLOU, M.Sc.

¹ The Imperial Department of Agriculture—W.I.B., vol. xi., Part 4, pp. 231-450.

Entomology in the West Indies—Ibid., pp. 282-317.

² MAXWELL-LEFROY, H., B.A., F.E.S., The Moth Borer of the Sugar Cane—W.I.B., vol. i., p. 329.

³ MAXWELL-LEFROY, H., B.A., F.E.S., The Lady-bird or Weevil Borer of the Sugar Cane—W.I.B., vol. iii., p. 88.

⁴ The Sugar-cane Beetle in Mauritius—A.N., vol. xi., No. 258, p. 90.

⁵ WATSON, Rev. N. B., The Root Borer of the Sugar Cane—W.I.B., vol. iv., p. 37.

⁶ White Ants attacking Sugar Canes—A.N., vol. v., p. 138.

⁷ BALLOU, H. A., M.Sc., Insect Pests of Cotton—W.I.B., vol. vi., p. 123.

⁸ BALLOU, H. A., M.Sc., Flower-bud Maggot of Cotton—W.I.B., vol. x., p. 1.

⁹ BALLOU, H. A., M.Sc., Insects attacking Cotton in the West Indies—W.I.B., vol. iv., p. 268.

- ¹⁰ The Cotton Leaf-blister Mite in Barbados—A.N., vol. xi., p. 106, March 30, 1912.
- ¹¹ BALLOU, H. A., M.Sc., Treatment of Cotton Pests in the West Indies, 1907—W.I.B., vol. ix., p. 235. (*Zalophothrix mirum* Crawford is a synonym of *Lecaniobius cockerelli* Ashmead.)
- ¹² Black Blight in Grenada—A.N., vol. iv., p. 394.
- ¹³ SOUTH, F. W., B.A. (Cantab.), Control of Scale Insects in the West Indies by means of Fungoid Parasites—W.I.B., vol. xi., p. 1.
- ¹⁴ Enemies of the Cotton Worm—A.N., vol. viii., p. 314.

DIE FOSSILEN TERMITEN: EINE KURZE ZUSAMMENFASSUNG DER BIS JETZT BEKANNTEN FUNDE.

Von KURT VON ROSEN, MÜNCHEN.

(Tafel XXVI–XXXI.)

NACHDEM A. HANDLIRSCH auf dem Ersten Entomologen-Congress in Brüssel einen Überblick über die gesamte fossile Insektenfauna gegeben hat,¹ sei es mir gestattet, die fossilen Vertreter einer einzelnen Insektengruppe kurz zu besprechen.

Nach HANDLIRSCH lassen sich fast alle der heute existierenden Insektenordnungen auf die Gruppe der paläozoischen **Palæodictyopteren** zurückführen—Insekten, die neben einer auffallend homonomen Segmentierung ein sehr primitives Flügelgeäder besaßen. Von den Entwicklungsreihen, welche bei den Palæodictyopteren ihren Ursprung nehmen, führt unter Anderem eine über die **Protoplattoideen** zu den **Blattoideen**. Hier sind nach Ansicht aller massgebenden Forscher die **Termiten** anzuschliessen, wobei die Meinungen geteilt sind, ob wir in den Blattoideen oder den Protoplattoideen die eigentlichen Vorfahren der Termiten zu erblicken haben. Fast alle rezenten Termiten besitzen secundär homonome Flügel, nur in Australien lebt eine Art, *Mastotermes darwiniensis* Frogg., welche durch das mächtig entwickelte Analfeld der Hinterflügel in ganz auffallender Weise an gewisse Blattiden erinnert. Da zudem alle Merkmale auf sehr primitive Organisationsverhältnisse hindeuten, so ist das Tier schon vielfach zu Schlussfolgerungen über die Abstammung der Termiten benutzt worden. In neuester Zeit hat besonders NILS HOLMGREN (*Termitenstudien*, II., pp. 14–33) diese Frage sehr

¹ Der Vortrag findet sich abgedruckt in den Verhandlungen des vorigen Congresses. Er stellt eine kurze Übersicht dar über das gewaltige Material, welches A. HANDLIRSCH ausführlich in seinem jedem Entomologen unentbehrlichen Werke, *Die fossilen Insekten u. die Phylogenie der rezenten Formen*, behandelt hat.

eingehend untersucht, und es ergab sich für ihn keine Möglichkeit, die Termiten von den Blattiden abzuleiten, dagegen sehr wohl eine, die Termiten den Protoblattoideen anzuschliessen. Da letztere bereits im Perm aussterben, haben wir nach HOLMGRENS Theorie das Auffinden von Termiten im **Mesozoicum** zu erwarten. Zwar beschrieben mehrere ältere Autoren wie HEER, GOLDENBERG, und selbst der Begründer des Termitensystems, HAGEN, eine Anzahl paläozoischer und mesozoischer Arten, aber bei genauerer Untersuchung derselben haben sich alle als zu anderen Ordnungen gehörig erwiesen. A. HANDLIRSCH hat dieser Frage besondere Aufmerksamkeit geschenkt; trotzdem gelang es ihm nicht, mesozoische Termiten zu entdecken. Ich konnte in letzter Zeit speziell die von HEER als Termiten beschriebenen Formen aus dem Lias von SCHAMBELEN untersuchen und muss mich durchaus der Ansicht HANDLIRSCH'S anschliessen, dass wir es hier mit Orthopteren zu tun haben. HANDLIRSCH stellt sie in die Gattung *Elcana* der Locustiden.

Da die grössten Veränderungen der Insekten gerade ins Mesozoicum fallen, und die tertiären Insekten nicht wesentlich von den rezenten abweichen, so können uns die bis jetzt bekannten fossilen Termiten in phylogenetischer Hinsicht nicht viel Interessantes bieten. Dagegen dürften sie für zoogeographische und klimatologische Fragen sehr wichtig sein, nachdem die Erforschung der rezenten Termiten in den letzten Jahren so ausserordentliche Fortschritte gemacht hat.

Die Termiten des Eocäns.

In seinem schon erwähnten Handbuch führt HANDLIRSCH als einzige eocäne Termiten *Termes Peccanae* Massolongo vom Monte Bolca an (p. 701 unter "Termitidæ incertæ sedis"). Aus der Abbildung Massolongos geht nach meiner Ansicht unzweifelhaft hervor, dass diese Art gar nicht zu den Termiten gehört, wie denn auch der Autor selbst die systematische Stellung des Fossils für durchaus zweifelhaft hielt. Kürzlich erhielt ich durch das Entgegenkommen des Herrn Dr. BATHER vom British Museum in London 4 Abdrücke von Termitenflügeln, welche aus dem Bagshot Beds von Bournemouth (Hampshire), stammen und nach Ansicht der Herren Geologen des British

Museum sicher dem *Oberen Eocän* (Bartonian) angehören. Nach genauem Vergleich mit *Mastotermes darwiniensis* Frogg. (Taf. XXVI, Fig. 1–2) bin ich sicher, eine fossile *Mastotermes*-Art vor mir zu haben, für die ich den Namen

***Mastotermes bournemouthensis* n. sp.**

vorschlage. Der Vorderflügel (Taf. XXVI, Fig. 3) zeigt einen unteren Radius sector-Stamm mit mindestens 7 parallelen Adern zum Vorderrande, eine noch innerhalb der Flügelmitte geteilte Mediana und einen reich verzweigten Cubitus. Die bei *Mastotermes* sehr auffallende Retikulierung des gesamten Flügelfeldes ist auch hier sehr deutlich. Die Stärke derselben nimmt bei den verschiedenen Familien in systematischer Reihenfolge progressiv ab, und bei den Protermitidæ sind die Flügel, mit wenigen Ausnahmen garnicht mehr retikuliert. Der Hinterflügel (Taf. XXVI, Fig. 4) ist leider recht unvollständig erhalten, doch erkennt man sofort die beiden Analadern ("falsche Rippe" und echte Analis), welche sich in dieser Ausbildung nur bei *Mastotermes* finden. Das Fehlen des grossen hinteren Anhangs (Postanalfeldes) wird nicht weiter überraschen, wenn man bedenkt, dass derselbe bei der lebenden Art unter den Flügel geklappt ist. Von *M. darwiniensis* unterscheidet sich diese Art hauptsächlich durch den viel reicher verzweigten unteren Radius sector-Stamm, ferner durch die grössere Breite des Vorderflügels. Es ist noch nötig, auf das verschiedene Stärkenverhältnis zwischen den vorderen und hinteren Adern gegenüber der rezenten Art hinzuweisen. Dadurch, dass der Vorderrand der Flügel etwas aufgebogen ist, wurden die vorderen Adern verhältnismässig schwach abgedrückt, die übrigen Adern, nämlich von der Mediana an, aber erscheinen auffallend kräftig. Es ist dies bei fast allen Abdrücken von Termitenflügeln der Fall. Bei den rezenten und in fossilen Harzen eingeschlossenen Formen sind umgekehrt die Adern des Radialfeldes am kräftigsten.

Nach dem oben Gesagten werden wir in dieser eocänen Termitenart nicht den ältesten Vertreter der Ordnung erblicken, aber es ist gewiss interessant, dass die ältesten *bekannten* Termiten gerade zu *Mastotermes* gehören.

Die Termiten des Oligocäns.

Da ich die Bernsteintermiten von den übrigen tertiären Arten gesondert behandeln möchte, seien jetzt die Termiten des englischen Oligocäns besprochen. Dr. BATHER hatte die grosse Freundlichkeit, mir das gesamte reichhaltige Material des British Museum zur Bearbeitung zu senden. Es handelt sich um 22 Flügelabdrücke aus dem *Mittleren Oligocän* der *Insel Wight*, dem an Insektenresten so überaus reichen "Insect Limestone" der Gurnard Bay. Viele der Flügel sind wunderbar erhalten und lassen sogar die ursprüngliche Färbung erkennen. Bei einem Tier konnte ich auch die Flügelschuppe sehr genau studieren. Alle 22 Exemplare gehören, das ist das Überraschende, zu *Mastotermes*. Trotz erheblicher Grössenunterschiede möchte ich 21 Exemplare zu *einer* Art rechnen, welche ich ***Mastotermes anglicus*** n. sp. nenne, während ein einzelner Hinterflügel so abweichendes Geäder besitzt, dass er wohl einer anderen Art angehört, für welche ich den Namen ***Mastotermes Batheri*** n. sp. wähle.

Die Deutung des Flügelgeäders von *Mastotermes darwiniensis*, wie sie HOLMGREN (*l.c.*) gegeben hat, scheint mir durchaus richtig zu sein. An Spiritusexemplaren kann man den Verlauf der Tracheen deutlich verfolgen. Der Vorderflügel (Taf. XXVI, Fig. 1) besitzt eine selten sichtbare *Costa* innerhalb der Schuppe. Die erste Ader, welche aus der Schuppe heraustritt—die *Subcosta*—ist unverzweigt, während der *Radius* die Schuppe als einfach gegabelte Ader verlässt. Beim *Radius sector* finde ich innerhalb der Schuppe 2–3 Äste, eine Verschiedenheit, welche bisweilen am gleichen Individuum zwischen linkem und rechtem Flügel ausgebildet sein kann. *Die Variabilität im Verlauf selbst der vorderen Rippen scheint mir bei allen niederen Termiten eine sehr grosse zu sein.* Ich habe darüber nirgends in der Literatur Angaben gefunden und möchte umso mehr die Aufmerksamkeit auf diese Tatsache lenken, als, wie wir sehen werden, das Geäder der *Calotermes*-Arten des Bernsteins dermassen variiert, dass es für spezifische Abgrenzung fast unbrauchbar ist. Beim Hinterflügel von *M. darwiniensis* (Taf. XXVI, Fig. 2), der hier ohne Schuppe abgebildet ist (infolgedessen die *Costa* fehlt), giebt es eine unverzweigte Sub-

costa, einen ebensolchen Radius; es folgen der Radius sector und die Mediana (an der Basis verbunden) mit lang verzweigten Ästen, ein reich verzweigter Cubitus und die beiden Analadern, schliesslich die Adern des Postanalfeldes.

Mastotermes anglicus n. sp. (Taf. XXVII, Fig. 5-8).

Die Art zeigt ein Geäder, welches ganz überraschend mit dem von *M. darwiniensis* übereinstimmt. Die Schuppe des auch hier sehr viel breiteren Vorderflügels (Fig. 5, 6) könnte ebensogut zu *M. darwiniensis* gehören. Ich verweise auf die Abbildungen und möchte nur auf das deutlich sichtbare rudimentäre Postanalfeld aufmerksam machen. Fig. 6 beweist, an wie verschiedenen Stellen sich die Adern links und rechts gabeln können. Am Hinterflügel (Fig. 8) giebt es der rezenten Art gegenüber einige wichtige Unterschiede: die Subcosta ist wesentlich kürzer, der Radius mit mehreren Nebenästen zum Vorderrande (gegen die Annahme, dass es sich um Zwischenadern handelt, spricht ihr Verlauf), der Radius sector und die Mediana sind ebenfalls reicher verzweigt, sehr ähnlich dagegen der Cubitus und die beiden Analadern, wenn man von der verschiedenen Stärke absieht. Das Postanalfeld ist bei keinem Stück deutlich erkennbar. Die Flügellänge variiert, ist aber im Allgemeinen dieselbe wie bei *M. darwiniensis*.

Mastotermes Batheri n. sp. (Taf. XXVIII, Fig. 9).

Radius sector und Mediana des Hinterflügels sind bei dem einzigen Exemplar sehr schwach verzweigt, ersterer mit nur 3-4, letztere mit 4 kurzen Ästen. Der vordere Cubitalstamm ist eigentümlich concav gebogen, was aber eine individuelle Abweichung sein dürfte. Das Geäder stimmt besser mit *M. darwiniensis*, als mit *M. anglicus* n. sp. überein.

Termitenabdrücke aus dem Oligocän sind auch in *Deutschland* gefunden worden. Hierher gehört *Termopsis Heerii* Goepp = *Hodotermes Heerianus* Assmann aus dem Oberen Oligocän von Schosnitz in Schlesien. Diese Art, von welcher nur die äussere Hälfte eines Flügels beschrieben wurde, war mir leider nicht zugänglich. Nach der Zeichnung von ASSMANN (*Schles. Zeitschr.*

Ent. (2), I., 45, tab. 1, Fig. 7) scheint es sich um den Vorderflügel einer *Mastotermes*-Art zu handeln.

Zum oberen Oligocän rechnet man auch die Ablagerungen von Rott im Siebengebirge, aus welchen HAGEN 2 Termitenreste als *Calotermes rhenanus* beschrieben hat (*Palæontographica*, 10, p. 250, t. 44, Fig. 1, 2). Aus dem British Museum, wo sich auch die Typen HAGENS befinden, erhielt ich ein 3. Stück (♂), welches durch die Grösse (Körper mit Flügeln 17 mm. gegenüber 10.5 mm.), die abweichende Kopfform und das Geäder deutlich von *Cal. rhenanus* Hag. verschieden ist. Leider sind gerade wichtige Teile (Basis und Vorderrand der Flügel, Pronotum) nicht zu erkennen, jedoch glaube ich, dass das Tier auf Grund folgender Merkmale zu *Hodotermes* Hag. gehört: Der Kopf ist fast rund, die Augen offenbar klein; ferner entsendet der Radius sector mehrere Adern zum Innenrand. Genaueres behalte ich mir vor.

HANDLIRSCH führt (*l.c.*, p. 702) noch zwei weitere Termiten aus dem Oligocän an. *Termes* sp. Förster von Brunnstatt im Elsass und *Termes Hassencampi* Heer von Sieblos in Bayern. Eine erneute Revision der Brunnstatter Insekten liess Förster zum Schlusse kommen, dass sich keine Termiten darunter befänden. So schreibt er in seinem Werke *Die Insekten des Plattigen Steinmergels von Brunnstatt*, p. 575: "Heuschrecken und Termiten fehlen." *Termes Hassencampi* ist ebenfalls keine Termiten (Phryganide?), wie ich nach sorgfältiger Untersuchung des schlecht erhaltenen Fossils (Type HEERS) berichten kann.

Die Termiten des Miocäns.

Die Besprechung der miocänen Termiten beginne ich mit denen des *Unteren Miocäns* von Radoboj in Croatien, welche seinerzeit von HEER sehr sorgfältig beschrieben wurden (*Insektenfauna der Tertiärgebilde von Oeningen und Radoboj in Croatien*, Teil II., 1849, pp. 22-34, t. II., f. 5, t. III., f. 3-5). Von den 5 Arten gehören 2 zu den Gattungen mit wohlentwickeltem Radialcomplex der Flügel, während die übrigen einen einfachen Radius sector besitzen und danach entweder zu den *Meso-* oder *Metatermitidae* zu rechnen sind. Was die ersten beiden Arten, *Termes procerus* Heer und *Termes Haidingeri* Heer betrifft,

so stellte sie HEER in die Untergattung *Termopsis* Heer, in welcher er alle heute in der Familie der *Protermitidae* zusammengefassten Arten unterbrachte. HAGEN fand (*Linnæa Entomologica*, x., pp. 97–101), dass diese Termiten ebenso wie *Termes spectabilis* Heer und *Termes insignis* Heer aus Oeningen "unzweifelhafte" *Hodotermes* seien. Aus dem Museum des Joanneums in Graz erhielt ich durch die freundliche Vermittelung des Herrn Professors HILBER neben den Typen HEERS auch noch 2 schön erhaltene Reste von Termiten ohne Fundortsangabe, welche aber nach dem Gestein zu urteilen, sicher aus den Radobojer Schichten stammen. Das eine Exemplar ist zwar etwas kleiner als die Type von *Termes procerus*, stimmt aber sonst gut mit derselben überein. Das andere Exemplar, von unbekannter Hand als "*Termes venosus* H." bezeichnet, hielt ich zunächst für keine Termiten, bis mich Dr. HOLMGREN dessen belehrte, dass hier der Hinterflügel einer *Mastotermes*-Art vorläge.

***Mastotermes croaticus* n. sp.**

wie ich diese Art benennen möchte, war damals der erste Vertreter dieser Gattung, welche mir zu Gesicht kam. Heute, wo ich sowohl rezente als auch fossile Vertreter von *Mastotermes* untersucht habe, muss es mir merkwürdig erscheinen, jenen Flügel nicht sofort richtig erkannt zu haben.

***Mastotermes croaticus* n. sp.** (Taf. XXVIII, Fig. 10) zeigt eine grössere Flügellänge (Hinterflügel 29 mm.), als die *Mastotermes*-Arten des Eocäns und Oligocäns und als die rezente Art. Sie ist jedenfalls sehr nah mit *M. anglicus* n. sp. verwandt, von welchem sie sich hauptsächlich durch die noch etwas stärkere Verzweigung des Radius sector und die bedeutendere Grösse unterscheidet. Leider fehlen die Adern vor dem Radius sector, dafür ist aber das umgeschlagene Postanalfeld teilweise als Anhang des Vorderrandes zu sehen. Dasselbe scheint noch etwas grösser als bei *M. darwiniensis* gewesen zu sein.

Nachdem einmal die systematische Stellung dieser Art geklärt war, untersuchte ich auch *Termes procerus* und *Haidingeri* auf ihre Zugehörigkeit zu *Mastotermes*. Während mir dieselbe bei *Haidingeri* ziemlich sicher zu sein scheint (wegen der breiten Hinterflügel mit teilweise gut sichtbarem Geäder), konnte ich

bei *procerus* zu keinem Resultat gelangen. Die Type von *Haidingeri* aus dem Wiener Hofmuseum zeigt annähernd die gleichen Masse wie *Mastotermis croaticus*. Es ist darum sehr wohl möglich, dass beide Arten identisch sind. Dass *T. procerus* (Taf. XXVIII, Fig. 11) ein *Hodotermes* sein soll, halte ich für vollkommen ausgeschlossen, denn 'dem widerspricht nicht nur das Geäder, sondern auch das sehr breite Pronotum (Taf. XXIX, Fig. 14). Die Mandibeln zeigen allerdings "Hodotermes-Bewaffnung," doch ist dieselbe auch für *Mastotermes* charakteristisch. Unter den *Hodotermitinae* besitzt nur *Pterotermes* ein sehr breites Pronotum, doch sind die Imagines dieser Gattung nicht bekannt. Der Bequemlichkeit halber gründe ich auf *Termes procerus* u. verwandte Arten eine neue Gattung unter dem Namen

Miotermes n. gen.

Grosse Arten. Kopf lang oval, Mandibeln mit *Hodotermes*-Bezahnung. Pronotum viel breiter als der Kopf, kragenförmig. Radius sector mit vielen Ästen zum Vorderrande, Mediana dem Radius sector genähert, ebenfalls reich verzweigt, Flügelmembran sehr stark retikuliert.¹ Typus dieser Gattung: *Termes procerus* Heer aus Radoboj. Die Stellung dieser Gattung im System bleibt ungeklärt, doch scheint eine Verwandtschaft mit *Mastotermes* ausser Frage zu sein. Hierher rechne ich noch folgende Arten: *Termes spectabilis* Heer und *insignis* Heer (vielleicht eine Art) aus Oeningen, *Hodotermes coloradensis* Scudd. aus Florissant und *Miotermes randeckensis* n. sp. von Randeck in Württemberg, alle zum Miocän gehörig.

Die 3 anderen Arten aus Radoboj sind *Metatermitiden*: *Termes pristinus* Charp. wurde von HEER in die Nähe von *Syntermes dirus* Klug gestellt. Ich habe 4 Exemplare aus dem Grazer Museum und 2 aus dem Wiener Hofmuseum gesehen. HOLMGREN sprach mir gegenüber die Ansicht aus, dass *pristinus* zu *Odontotermes* gehöre. In der Tat scheinen Mediana und Cubitus des Vorderflügels eine gemeinsame Basis zu haben. Leider ist kein einziges Stück so gut erhalten, als dass sich diese Frage sicher entscheiden liesse.

¹ Wie man sieht, findet sich kein Merkmal, welches gegen die Identität mit *Mastotermes* spricht.

Da die Flügelform innerhalb der einzelnen Termitengattungen sehr wechselt, so lässt sich auch die systematische Stellung von *Termes obscurus* Heer und *Termes croaticus* Heer nicht näher präzisieren, obgleich erstere Art sehr dunkle, im äusseren Drittel stark verbreiterte, und letztere umgekehrt sehr helle und schmale Flügel zeigt. Es kommen für diese Arten sowohl die *Hamitermes*- und *Miro-Capritermes*-Reihen, als auch die *Syntermes*-Reihe in Betracht.

Die Termiten des *Oberen Miocäns* von Oeningen haben wir bereits teilweise kennen gelernt (*Termes spectabilis* Heer und *insignis* Heer). Aus der geologischen Sammlung des Eidgenössischen Polytechnikums in Zürich erhielt ich durch die Freundlichkeit von Herrn Professor Dr. SCHARDT einige Oeninger Termiten, darunter die Type von *Termes Hartungi* Heer. HEER hat diese Art richtig mit *Leucotermes lucifugus* verglichen, denn es scheint vollkommen sicher zu sein, dass *Hartungi* ein *Leucotermes* ist. Die Art ist in HEERS *Urwelt der Schweiz* (II. Aufl. p. 392, Fig. 271) einigermassen kenntlich abgebildet. Falls der mir als *Termes Büchii* übersandte Flügelrest wirklich die Heersche Type darstellt, so wird sich diese Art wohl nie deuten lassen, da vom Geäder keine Spur zu erkennen ist. Der lebhaft braun gefärbte Vorderrand spricht vielleicht für eine Metatermitide. In der Grösse stimmt damit ziemlich überein ein gut erhaltener Flügel von 11 mm. Länge und 3·5 mm. Breite, welcher einer noch unbeschriebenen *Calotermes*-Art angehört, für welche ich den Namen nach dem Fundort wähle.

***Calotermes oeningensis* n. sp.**

Nur ein Seitenzweig und der Hauptstamm des Radius sector sind zu erkennen, dagegen ist die ganze stark verzweigte Mediana und ebenso der Cubitus schön erhalten.

Gleichfalls zum *Oberen Miozän* gehören die Randecker Fossilien, unter denen sich im Stuttgarter Naturalienkabinett 2 Termitenarten befinden.

***Miotermes randeckensis* n. sp.**

Nahe verwandt mit *Miotermes procerus* Heer, welche ein ähnlich gebautes Pronotum besitzt. Auch in Bezug auf die

Grösse steht *M. randeckensis* dieser Art näher als *M. spectabilis* Heer, an welche wegen der gleichen geologischen Schicht eher zu denken wäre. Breite des Kopfes und Pronotums respective 4 und 5 mm. (Fig. 14). Die Flügel (Vorder) nur bis zur Stelle erhalten, wo der 2. Seitenast des unteren Radius sector-Stammes abzweigt.

Eine sichere Metatermitide ist die andere Art aus Randeck.

Eutermes (s.l.) Fraasi n. sp.

Flügelgeäder schön erhalten, leider fehlen Kopf, Pronotum und Schuppe, so dass sich die Stellung im System nicht genauer angeben lässt.

Länge und Breite des Vorderflügels respective 11.5 mm. und 3 mm. Von *Termes obscurus* Heer aus Radoboj durch die geringere Grösse (*obscurus* zeigt eine Flügellänge von 14 mm. bei einer Breite von 4 mm.) und die hellere Färbung, von *Termes croaticus* Heer ebenfalls durch die geringeren Masse unterschieden.

Die Termiten des Miocäns von Florissant in Colorado kenne ich nur aus der Beschreibung von Scudder (*Tertiary Insects*, pp. 103–116, tab. 12, f. 2, 3, 6, 12–14, 17, 20, 22). Scudder begründete für 3 Arten die Gattung *Parotermes*, welche sich von *Hodotermes* Hag. durch die Anwesenheit der Subcosta ("submarginal vein") und von *Calotermes* durch verhältnismässig kürzere Flügel und die Abwesenheit der Ozellen unterscheiden soll. *Parotermes insignis* Scudd. könnte nach der Abbildung eine Termopsis-Art sein, während *Parotermes Hageni* Scudd. und *fodinae* Scudd. nach der Beschreibung und Abbildung nicht von *Calotermes* zu unterscheiden sind. *Hodotermes coloradensis* Scudd. stelle ich, wie bereits erwähnt, in die Gattung *Miotermes* n. gen. *Eutermes Meadii* Scudd. dürfte ein *Leucotermes* sein, nahe verwandt mit *Leucotermes Hartungi* Heer aus Oeningen. Von *Eutermes fossarum* Scudd. lässt sich nur sagen, dass hier eine *Metatermitide* vorliegt. Eine Klärung wird erst die genaue Untersuchung der SCUDDERSCHEN Typen bringen. SCUDDER kannte die rezenten Termiten offenbar nur sehr mangelhaft, und deshalb haben seine ausführlichen Beschreibungen wenig Wert.

Auch die Termiten des sizilianischen Bernsteins, welche

nur von HAGEN kurz erwähnt werden, konnte ich zur Zeit noch nicht untersuchen. Für den Vergleich mit den Bernstein-terminen sind sie ausserordentlich wichtig.

Die Termiten des Baltischen Bernsteins.

Ich habe mit Absicht vor dem Bernstein, in welchem uns die reichste fossile Termitenfauna erhalten ist, weit jüngere Ablagerungen besprochen, weil über sein Alter die Meinungen der Geologen noch immer auseinander gehen (*Unteres Oligocän* oder *Oberes Eocän*).

Bei diesem ungeheuren Alter muss man über die wunderbare Erhaltung der eingeschlossenen Insekten staunen, lässt sich doch in vielen Fällen ihr äusserer Bau genau so gut wie an lebenden Tieren studieren; man ist ferner überrascht über die grosse Verwandtschaft der Bernsteinfauna mit der rezenten. Was nun die Bernsteinterminen betrifft, so fallen bei ihnen 2 Tatsachen besonders auf: 1, **fehlen alle höheren Termiten**, welche von HOLMGREN in der Familie der *Metatermitidæ* vereinigt wurden und die *ca.* $\frac{3}{4}$ der rezenten Arten umfassen; 2, finden sich nur Imagines und zwar Imagines mit Flügeln oder solche, welche die Flügel abgeworfen haben, dagegen keine Arbeiter, Soldaten, und Larven (bis jetzt ist nur eine einzige Termitenlarve gefunden worden). Wer zu voreiligen Schlüssen neigt, könnte meinen, es hätten zur Bernsteinzeit noch keine höheren Termiten existiert. Dagegen sprechen aber nicht nur die Befunde bei anderen Insektenordnungen, sondern auch die **äusserst nahe Verwandtschaft einiger Bernsteinterminen mit rezenten Arten**. Es giebt meiner Meinung nach nur eine Erklärung, und die liegt im **Klima der Bernsteinlandschaft**. Fast alle rezenten Metatermitiden gehören nämlich Ländern mit durchaus tropischem Klima an, und für die Bernsteinlandschaft muss ich ein Klima annehmen, wie es heute die Mittelmeerländer und die südlichen Provinzen der Vereinigten Staaten von Nordamerika besitzen. Bevor ich diese Ansicht durch Vergleich einiger Bernsteinterminen mit rezenten Arten begründe, möchte ich versuchen, das vollständige Fehlen der Arbeiter und Soldaten zu erklären. Bekanntlich stellt der Bernstein das Harz von Coniferen dar. In Nadelhölzern leben aber meines Wissens

die rezenten Termiten nur sehr selten. Die Arbeiter und Soldaten verlassen ihren Bau in der Regel nur in gedeckten Gängen (Galerieen). Es giebt zwar in den Gattungen *Hodotermes* und *Eutermes* einige Ausnahmen, doch kommen die hier nicht in Betracht. Die Arbeiter und Soldaten mussten also, um in den Bernstein zu gelangen, entweder im Baume leben, welcher das Harz absonderte und dessen Inneres verlassen, oder aber in anderen Bäumen und dann Galerieen bis zum Bernsteinbaume anlegen, denn alle im Bernstein gefundenen Arten gehören zu den Holztermiten. Die erste Annahme ist, wie wir gesehen haben, unwahrscheinlich. Die zweite Möglichkeit fällt von vornherein für die Gattungen der *Termopsinæ* und für *Calotermes* fort, welche keine Galerietermiten sind und keine grossen Wanderzüge unternehmen. Somit bleiben nur die *Leucotermes*-Arten übrig, und für dieselben ist es charakteristisch, dass sie meist totes Holz angreifen, mithin nicht solches, welches Harz absondert. Die Geflügelten aller Arten aber, welche in grossen Schwärmen ihre Nester verlassen und vom Winde überallhin vertrieben werden, konnten natürlich leicht in das Bernsteinharz gelangen. Mir scheint also das Fehlen der Arbeiter und Soldaten durch die Natur des Bernsteinbaumes (Conifere) mit bedingt zu sein. Für ebenso wichtig halte ich aber die Tatsache, dass keine Arten vertreten sind, welche Hügel-, Erd- oder Baumnester bewohnen und von diesen aus die umliegenden oder entfernteren **lebenden** Bäume und Sträucher mit ihren Galerieen überziehen. Wenn wir, wie dies weiter unten geschehen soll, die afrikanischen Kopaltermiten betrachten, so finden wir unter ihnen gerade die Arbeiter und Soldaten solcher Arten vertreten, welche die kunstvollsten Bauten construieren (*Termes*, *Eutermes*, *Microccrotermes*). Ausserdem gehört bekanntlich der Kopalbaum zu den Laubhölzern.

Die einzelnen Arten der Bernsteintermiten kann ich umso kürzer behandeln, als ich eine ausführliche Arbeit über dieselben demnächst veröffentlichen werde.

HAGEN beschrieb aus dem Bernstein 3 Arten der Gattung *Termopsis*, *T. Bremii* Heer, *gracilicornis* Pictet, und *decidius* Hag. Trotzdem mir die Typen der letzteren vorliegen, vermag ich keinen spezifischen Unterschied gegenüber *T. Bremii* zu finden. Bei der grossen Variabilität der *Protermitidæ* hinsichtlich des

Flügelgeäders und der Grösse möchte ich annehmen, dass alle 3 Formen einer einzigen Art angehören. Die im Bernstein häufige *T. Bremii* Heer (Fig. 17) unterscheidet sich von beiden rezenten Arten durch die abweichende Bedornung der Tibien, indem die Mitteltibien nur einen Lateraldorn nahe der Spitze, die Vordertibien keinen Lateraldorn besitzen. *Termopsis angusticollis* Hag. und *laticeps* Banks zeigen an allen Tibien mehrere Lateraldornen, auch die Form des Pronotums ist eine andere. In einem Fall, wo der Vorderflügel vollständig zu sehen war, fand ich eine deutlich geteilte Subcosta (Fig. 13), wie sie nur bei *Archotermopsis* vorkommt. Wegen dieser Unterschiede scheint mir die Aufstellung einer neuen Gattung berechtigt. Indem ich *T. angusticollis* als Typus der Gattung *Termopsis* Heer betrachte, wähle ich für *Bremii* Heer den Gattungsnamen

Xestotermopsis n. gen.

Zu den *Termopsinæ* gehört noch eine andere Bernsteinermite, welche mir schon bei flüchtiger Betrachtung aufgefallen war. Nach den stark bedornen Tibien, den nierenförmigen Augen und den auffallend langen Cerci kann kein Zweifel bestehen, dass wir es mit einer fossilen *Archotermopsis*-Art zu tun haben. Das (Taf. XXIX, Fig. 18) abgebildete Stück zeigt Mandibeln mit "*Leucotermes*"-Bezahnung. Ich benenne diese interessante Art nach Herrn Professor Dr. TORNQVIST, Direktor des Königsberger Bernsteinmuseums,

Archotermopsis Tornquisti n. sp.

Alle *Calotermes*-Arten des Bernsteins besitzen gegenüber den rezenten Formen Lateraldornen an den Mitteltibien. Bei einer Art, *Calotermes Berendtii* Pict., findet sich auch an den Hintertibien je ein Lateraldorn; die Mitteltibien zeigen 3 Lateraldornen, davon 2 in einer Reihe (Fig. 15). Das Geäder ist das der Untergattung *Neotermes* Holmgr. (*Mediana* dem *Radius sector* stark genähert, ebenso deutlich wie dieser), die Fühler mit 19 Gliedern (Fig. 19). Alle übrigen Arten mit 14–17-gliedrigen Fühlern bilden zusammen eine Gruppe, indem sich nur an den Mitteltibien 2 Lateraldornen in einer Reihe (Fig. 16)

befinden (ausnahmsweise 1 oder 3). Die Mediana ist dem Radius sector mehr oder weniger genähert, d.h. zeigt eine Mittelstellung zwischen den Untergattungen *Calotermes* s. str. Holmgr. und *Neotermes* Holmgr. (Taf. XXVIII, Fig. 12, XXX, Fig. 20–21). Diese bedeutenden Unterschiede gegenüber den bisher bekannten Untergattungen von *Calotermes* veranlassen mich, zwei neue Untergattungen aufzustellen:

Proelectrotermes n. subg. (Typus *Calotermes Berendtii* Pict.).

Electrotermes n. subg. (Typus *Calotermes affinis* Hag.).

Von *Electrotermes* liegen mir ca. 150 Exemplare vor und unter denselben finden sich kaum 2 Stücke, welche dasselbe Geäder besitzen. Verschmelzung von Hauptadern, wodurch dieselben bisweilen zu fehlen scheinen, abnorme Ausdehnung der Mediana auf Kosten des Cubitus sind gar nicht selten und können sowohl symmetrisch als auch nur einseitig ausgebildet sein. Unter Zuhilfenahme der Form des Pronotums, der Fühlergliederzahl und der Grösse glaube ich 5 Arten sicher unterscheiden zu können, doch handelt es sich zweifellos um sehr nahe verwandte Formen, die es verständlich machen, dass HAGEN nur eine einzige Art anerkannte.

Die *Mesotermitidae* sind im Bernstein nur durch die Gattung *Leucotermes* Silv. vertreten. Ich kann mit Sicherheit 3 Arten unterscheiden, von denen *Leucotermes antiquus* Germ. äusserst nah verwandt ist mit der südeuropäischen Art *L. lucifugus* Rossi, *L. borussicus* n. sp. dagegen mit *L. virginicus* Banks aus Nordamerika, während *L. robustus* n. sp. durch den auffallend breiten Kopf eine isolierte Stellung einnimmt. Alle 3 Arten gehören zur Untergattung *Reticulotermes* Holmgr., welche kürzlich von HOLMGREN auf Grund der schwachen Behaarung und der am Vorderrande deutlich retikulierten Flügel aufgestellt wurde. Von rezenten Arten gehören hierher: *L. lucifugus* Rossi (Mittelmeerländer), *L. flavipes* Kollar (Nordamerika), *L. speratus* Kolbe (Japan), und *L. virginicus* Banks (Nordamerika).

Die *Leucotermes*-Arten des Bernsteins sind somit Zeugen eines gemässigten Klimas. Die Vertreter der Gattung *Calotermes* besitzen in der rezenten Fauna keine näheren Verwandten und sind daher für einen Vergleich nicht geeignet. Die *Termopsinae* kennt man bis jetzt in folgenden Arten: *Archotermopsis*

—1 Art aus Kashmir; *Hodotermopsis*¹—2 Arten aus Formosa und Tonkin; *Termopsis*—2 Arten aus den Vereinigten Staaten von Nordamerika. Für die Annahme, dass im Bernsteinlande ein gemässigttes Klima geherrscht hat, sprechen somit mehrere Arten (*Archotermopsis*, *Leucotermes*), andere lassen die Frage unentschieden (*Xestotermopsis*, *Calotermes*), während es dagegen keine Art giebt, die dagegen sprechen würde.

In den übrigen tertiären Schichten fanden sich, wie wir sahen, mehrere Zeugen eines tropischen Klimas. Ich erinnere nur an *Odontotermes pristinus* Charp., *Eutermes obscurus* Heer, *E. croaticus* Heer aus Radoboj, *Eutermes fossarum* Scudd. aus Florissant, *Eutermes Fraasi* n. sp. aus Randeck. Das am meisten südlich gelegene Radoboj stellt hierbei das Hauptkontingent. Schliesslich gehören in diese Gruppe wahrscheinlich auch die fossilen *Mastotermes*-Arten, deren einziger rezenter Verwandter sich in Australien bis auf ca. 12° dem Aequator nähert. Stellen die uns im Gestein erhaltenen Tertiären Arten nur einen kleinen Bruchteil der damaligen Termitenfauna dar, so ist doch ihr sehr abweichender Charakter gegenüber den *Bernsteintermiten* auffallend. Besonders bemerkenswert für die Bernsteinfauna scheint mir das Fehlen von *Mastotermes*.

Die afrikanischen Kopaltermiten.

Wie die Kopalinsekten im Allgemeinen, so sind auch die Kopaltermiten nie Gegenstand eingehender Untersuchungen gewesen. Bekanntlich kommt der Kopalbaum, *Trachylobium mossambicense*, in manchen Gegenden Afrikas auch noch heute vor, und die in seinem Harze eingeschlossenen Insekten stellen somit häufig Bestandteile der heutigen Fauna dar. Schon an der hell- bis dunkelgelben Farbe des Kopals lässt sich annehmen, dass es Kopale von sehr verschiedenem Alter giebt. So wird Kopal in manchen Gegenden aus grösseren Tiefen gegraben, was auf ein hohes Alter deutet. Leider ist der genaue Fundort meist nicht zu erfahren, und nach der Farbe allein lässt sich die Frage nicht entscheiden, ob man rezenten oder sogenannten subfossilen Kopal vor sich hat.

¹ Nur die Soldaten und Arbeiter dieser Gattung sind bekannt. Sie besitzen keine Lateraldornen an den Vorder- und Mitteltibien, weshalb an eine Verwandtschaft mit *Xestotermopsis* gedacht werden kann.

Unter den mir vorliegenden Kopaltermitten giebt es Arten, welche mit rezenten identisch zu sein scheinen, aber auch solche, welche sicher verschieden sind, wie sich trotz der vielfach unsicheren Bestimmung feststellen liess (nach dem jetzigen Stand der Termitenforschung). Ich gebe hier ein Verzeichnis der Kopaltermitten, welche ich gesehen habe.

Protermitidæ.

<i>Calotermes (Calotermes) resinatus</i> n. sp., Goldküste	} Imagines.
<i>Calotermes (Calotermes) crythroptus</i> n. sp., Ostafrika	
<i>Calotermes (Calotermes)</i> sp. (alle Klauen ohne Haftlappen), Deutsch-Ostafrika	
<i>Calotermes (Neotermes)</i> sp. = <i>pallidicollis</i> Sjöst ?, Ostafrika	
<i>Calotermes (Cryptotermes) Batheri</i> n. sp., Ostafrika	
<i>Calotermes (Glyptotermes) pusillus</i> Heer, Goldküste, Ostafrika, Sansibar	

Mesotermidæ.

Coptotermes, 3-4 Arten von verschiedenen Fundorten.
Rhinotermes sp. = *Rh. Lamanianus* Sjöst ?, Sansibar.

Metatermitidæ.

<i>Termes (Termes) amicus</i> n. sp., Ostafrika, kleiner Soldat und Arbeiter.	} Imagines
<i>Termes (Termes)</i> sp., wahrscheinlich = <i>Goliath</i> Sjöst., Deutsch-Ostafrika, grosser Soldat.	
<i>Odontotermes</i> , 2 Arten, Goldküste, Deutsch-Ostafrika	
<i>Microtermes</i> sp ?, Ostafrika	} Imagines.
<i>Eutermes (Trinervitermes) Handlirschi</i> n. sp., Goldküste.	
<i>Eutermes (Trinervitermes)</i> sp., Sansibar.	
<i>Mirotermes resinatus</i> n. sp., Ostafrika	
<i>Mirotermes</i> sp., Ostafrika	
<i>Microccrotermes latinotus</i> n. sp., Ostafrika	
<i>Microccrotermes</i> sp., Ostafrika, Arbeiter.	

Aus diesem Verzeichnis ist zu ersehen, dass im Kopal nur von *Metatermitidæ* Arbeiter und Soldaten bekannt sind, eine Tatsache, die ich schon bei der Besprechung der Bernsteintermitten zu erklären versuchte.

Eine der häufigsten Kopaltermitten ist *Glyptotermes pusillus*

Heer (Taf. XXX, Fig. 23), leicht kenntlich an den 11-gliedrigen Fühlern. Sie wurde in der rezenten Fauna bisher nicht gefunden. HAGEN nahm zwar Südamerika als Heimat an, weil er ein Stück zusammen mit *Calotermes brevis* Walk. eingeschlossen fand. Dies beruht sicherlich auf einem Irrtum, da HAGEN'S Beschreibung keinen Zweifel lässt, dass die afrikanische Kopalart gemeint ist. Der angebliche *Calotermes brevis* dürfte wohl mit *Cryptotermes Batheri* n. sp. identisch sein. Sehr häufig sind ferner die *Coptotermes*-Arten (Taf. XXX, Fig. 24), während sich von *Eutermes* bisweilen grosse Mengen von Arbeitern und Soldaten eingeschlossen finden (Taf. XXXI, Fig. 26). ESCHERICH hat in seinem *Termitenleben auf Ceylon* u. A. ausführlich geschildert, wie sich die Arbeiter bei Zerstörungen ihrer Galerien verhalten. Sofort stürzen die in der Nähe befindlichen Arbeiter und Soldaten zur schadhaften Stelle, und während sich die ersteren als Baumeister betätigen, sind die Soldaten bereit, jeden Feind anzugreifen. Während dieser Tätigkeit müssen die auf der Photographie (Taf. XXXI, Fig. 26) dargestellten Tiere vom Harzfluss überrascht worden sein. Zum Schluss sei noch auf *Mirotermes resinatus* n. sp. (Taf. XXXI, Fig. 27) als ebenfalls charakteristisch für den Kopal hingewiesen.

Durch diese kurze Betrachtung hoffe ich gezeigt zu haben, dass die Kopalinsekten ein genaues Studium durchaus verdienen, und ich möchte alle Entomologen bitten, der Kopalfauna erhöhte Aufmerksamkeit zu schenken. Liegt erst ein reichliches Material mit genauer Fundortangabe vor, so werden wir sicherlich einen interessanten Einblick in die Veränderungen, einer tropischen Fauna während der jüngsten geologischen Epochen gewinnen.

ERKLÄRUNG DER TAFELN XXVI–XXXI.

- TAF. XXVI. Fig. 1.—*Mastotermes darwiniensis* Frogg., Vorderflügel; Vergr. 6×.
 Fig. 2.—*Mastotermes darwiniensis* Frogg., Hinterflügel; Vergr. 6×.
 Fig. 3.—*Mastotermes bournemouthensis* n. sp., Vorderflügel; Vergr. 6×.
 Fig. 4.—*Mastotermes bournemouthensis*, Hinterflügel; Vergr. 6×.

- TAF. XXVII. Fig. 5.—*Mastotermes anglicus* n. sp., Teil der Vorderflügel;
Vergr. 6×.
Fig. 6.—*Mastotermes anglicus* n. sp., Schuppe des Vorderflügels; Vergr. 20×.
sc = Subcosta; r = Radius, rs = Radius sector;
m = Mediana; cu = Cubitus; pa = Postanalfeld.
Fig. 7.—*Mastotermes anglicus* n. sp., Vorderflügel;
Vergr. 6×.
Fig. 8.—*Mastotermes anglicus* n. sp., Hinterflügel;
Vergr. 6×.
Figurenbezeichnung wie bei Fig. 6.
- TAF. XXVIII. Fig. 9.—*Mastotermes Batheri* n. sp., Hinterflügel; Vergr. 6×.
Fig. 10.—*Mastotermes croaticus* n. sp., Hinterflügel;
Vergr. 5½×.
Fig. 11.—*Miotermes procerus* Heer, Teil des Vorder- und Hinterflügels; Vergr. 4×.
Fig. 12.—*Calotermes (Electrotermes) affinis* Hag., Vorderflügel; Vergr. 7×.
- TAF. XXIX. Fig. 13.—*Nestotermopsis Bremii* Heer, Vorderflügel;
Vergr. 9×.
Fig. 14.—*Miotermes procerus* Heer, Kopf und Pronotum.
Fig. 15.—*Calotermes (Proelectrotermes) Berendtii* Pict., Mittelbein.
Fig. 16.—*Calotermes (Electrotermes) Girardi* Gieb., Mittelbein.
Fig. 17–22 Photographieen von Bernsteinermitten.
Fig. 17.—*Nestotermopsis Bremii* Heer.
Fig. 18.—*Archotermopsis Tornquisti* n. sp.
- TAF. XXX. Fig. 19.—*Calotermes (Proelectrotermes) Berendtii* Pict.
Fig. 20.—*Calotermes (Electrotermes) Girardi* Gieb. (?)
Fig. 21.—*Calotermes (Electrotermes) Girardi* Gieb.
Fig. 22.—*Leucotermes (Reticulotermes) antiquus* Germ.
Fig. 23–27 Photographieen von Kopaltermiten.
Fig. 23.—*Calotermes (Glyptotermes) pusillus* Heer.
Fig. 24.—*Coptotermes* sp.
- TAF. XXXI. Fig. 25.—*Termes amicus* n. sp.
Fig. 26.—*Eutermes* sp.
Fig. 27.—*Mirotermes resinatus* n. sp.
Figs. 1–11, 12, 16, 18, 21, 25, 27 nach den Typen.

ON THE SCENT-PATCHES OF THE PIERINÆ.

By F. A. DIXEY, OXFORD.

It is well known that the males of many species of Pierine butterflies are furnished with an apparatus for distributing the characteristic odour, which is generally of an agreeable nature, belonging to that sex. This apparatus usually takes the form of specialised scales, which may be either scattered broadcast over the wings, or collected into more or less definite patches. In the former case the scales are as a rule of the kind known as "plume-scales," being provided at the distal extremity with a tuft or fringe of delicate chitinous tubules which appear to be pervious, and so to allow the escape of the volatile substance, probably of an oily nature, which carries the perfume. In the latter case, though the scales may sometimes be of the plume-bearing kind, it more often happens that they are without the plume-like appendage, though they show other evident marks of specialisation when compared with the ordinary scales of the wing. Plume-scales are almost invariably confined to the upper surface of the wings; scent-scales of the other kind may be found on either the upper or lower surface, in many cases on both.

In several species of the genus *Dismorphia* the scent-scales of each wing are collected into an oval patch, usually quite conspicuous, which is situated on the lower surface of the forewing and the upper surface of the hindwing. These patches are so placed that in the ordinary position of rest the forewing patch is superimposed upon the patch of the hindwing, and the escape of the odour from both is presumably thereby prevented. During flight, both patches present a free surface to the atmosphere, and no apparent obstacle exists to the dispersal of the perfume. In *Dismorphia* (*Acmepteron*) *nemesis* each oval patch is surrounded by a smooth, shining area with a silky or pearly lustre, the oval patch itself having a roughened or "chalky" appearance. These differences are due partly

to the size and structure of the scales themselves, partly to the mode in which the scales are inserted into the wing. The scales constituting the oval patch are large, about six or seven times as long as broad, and with sides roughly parallel. Those of the silky area are small, oval or pear-shaped, attached by the broader end. The scales of the oval patch are set up at an angle and overlap; those of the silky area are arranged like a mosaic and are closely appressed to the surface of the wing. The silky area and chalky patch together occupy about three-quarters of the area of the forewing, and a little less than half that of the hindwing. The object of the silky patches, with their pavement-like arrangement of scales, may be to ensure the smooth sliding over one another and the close fitting together of the surfaces which are apposed during rest. When the silky patches coincide, the chalky patches coincide also, and the insect is in the normal position of repose. It is perhaps conceivable that the sliding together of the two smooth surfaces may give rise to a tactile impression which assists the butterfly in assuming the appropriate attitude. An interesting point is that the ordinary pattern of the wing is not continued on the silky areas, being confined to those regions which are visible while the insect is at rest. This is a strong argument in favour of the view that the wing-pattern has been evolved under the influence of natural selection.

When the wing has been denuded of scales, the position of the scent-patch is still clearly indicated by the more cloudy appearance of the wing-membrane in that situation. On examination this is seen to be due to the presence of the special sockets which serve for the attachment of the scent-scales. These sockets, which are considerably larger in every dimension than those belonging to the ordinary scales of the wing, are confined, as has been seen, to one surface—the lower surface of the forewing, the upper surface of the hindwing. They are very easily distinguishable from the ordinary sockets on microscopic observation, not only by their superior size, but also from the fact that they focus at a different level.

In *Acmepteron virgo* Bates, the male has similar oval patches in the corresponding situation on the fore- and hindwing. The silky area surrounding the oval patches extends even farther

over the wing than in *A. nemesis*, but the boundaries of both area and patch, especially of the hindwing, are less well defined than in that species. This is partly due to the fact that the scales of both patch and area are in the hindwing of nearly the same whitish tint; while in the forewing the scales of the oval patch are of two kinds, one of which is not confined to the patch itself, but extends beyond the borders of the patch over nearly the whole of that part of the silky area which lies between the first median and the upper radial vein. A result of this arrangement is that the distal border of the patch is somewhat less sharply defined than in *A. nemesis*, and that on a naked-eye view a kind of cloudiness, due to the presence of these widely-dispersed scales, pervades the part of the silky area that has been named. The scales which are common to both patch and silky area may be described as elongate cordate, or club-shaped, tapering regularly towards a narrow proximal extremity, and with the distal border slightly bifid. These are thickly interspersed among the scales proper to the region, which in the scent-patch are elongated elliptical, about five times as long as broad, and smaller in all dimensions than in *A. nemesis*. The scales of the hindwing patch are similar, but less elongated and broader in proportion. Those of the silky areas are much like those in *A. nemesis*, but have the sides more nearly parallel. They are larger on the hindwing than on the forewing. The sockets of both kinds of specialised scales are easily distinguishable microscopically from each other and from those of the ordinary scales clothing the other surface—lower or upper as the case may be. In a denuded wing-membrane the sockets of the ordinary scales appear as simple cups; those of the specialised scales are ill-defined and somewhat opaque, the latter character seeming to be due to an abundant wrinkling of the wing-membrane in their immediate vicinity. Those of the scales peculiar to the scent-patch are distinguishable by their superior size. Both kinds of specialised scales are altogether absent in the female.

The male of *Dismorphia praxinoe* Doubl. has two large white patches, one occupying about two-thirds of the lower surface of the forewing, the other nearly half of the upper surface of the hindwing. The silky area in this species is not well

defined, but it exists as a comparatively narrow border to the white patch in both fore- and hindwing. The scales composing the white patch are in each case of a specialised kind. In the hindwing they are elongate oval, much like those of *A. virgo*. In the forewing the proximal part of the patch is entirely composed of scales of this character, but distally these become mingled with other scales of the same general type as the club-shaped scales in *A. virgo*, but shorter, less gradually tapering, and with the distal margin simply rounded and not bifid. As in *A. virgo*, scales of this latter kind are continued over the surface of the wing to some distance beyond the edge of the scent-patch. In both species they appear to be absent from the hindwing, where the scales of the white patch are of one uniform appearance. The scales peculiar to the scent-patch are in *D. praxinoe* very heavily loaded with white pigment; apparently much more so than in *A. virgo*. In both species the club-shaped scales are comparatively devoid of pigment, and show a coarsely-meshed chitinous reticulum.

In *Dismorphia fortunata* Luc., the conspicuous white patch on the undersurface of the forewing in the male occurs chiefly on the inner side of the median, and is traversed by the three branches of that vein. It consists almost entirely of a dense mass of long, curving hairs closely matted together, and intermixed with a few oval scales of a type intermediate between the ordinary form and the fully developed hair. These hairs are absent from the hindwing, but the whitish, opaque area of the costal portion upper surface shows a pavement-like assemblage of elongated oval scales, somewhat similar to those of the scent-patches in *A. virgo*.

In *Dismorphia pallidula* Butl. & Druce the scent-patches are well defined. They form oval marks of a brown colour in the usual situation on the fore- and hindwing. The scales composing them are very closely packed, set up on the wing at a considerable angle, and well furnished with pigment. It is noticeable that though they are all of the elongated oval type, those of the forewing are mostly somewhat narrowed towards the proximal extremity, while those of the hindwing have the sides nearly parallel.

In no species of *Dismorphia* or *Acmepteron*, so far as I am

aware, is there any special distribution of air-tubes to the scent-patches. But in several other Pierine genera, *e.g.* *Catopsilia*, *Colias*, *Teracolus*, the specialised patches, when present, are provided with a plentiful supply of ramifying "tracheæ," somewhat similar to those described and figured by FRITZ MÜLLER in the Satyrine butterfly *Antirrhæa archæa* Hübn. In *Teracolus fausta* Oliv. the male is furnished on the lower surface of the forewing with a well-defined scent-patch. This is pervaded by numerous tracheæ which, starting at right angles from the submedian vein, run roughly parallel to one another through the patch, giving off numerous fine ramifying branches. These latter form a reticulum with hexagonal meshes, the interstices of which appear to correspond with the sockets for the insertion of the specialised scent-scales, there being usually one such socket to each interspace. Besides this reticular structure, still finer ramifications are visible, some of which in a few instances seem to end in connection with the proximal extremities of the scale-sockets.

In *Catopsilia florella* Fabr. the scent-patch on the upper side of the hindwing is well furnished with tracheal branches, the general arrangement of which is not unlike that in *Teracolus fausta*. The main tracheal branches run forward from the subcostal nervure in a row like the teeth of a comb, traversing the scent-patch, and becoming lost to view immediately beyond it. Each socket belonging to a specialised scent-scale occupies a definite area of the wing-membrane; these areas appear to correspond with the hexagonal reticulum in *T. fausta*, but the connection with tracheal ramifications is less evident, and the areas have a rounded rather than a hexagonal contour. Their appearance in a patch denuded of scales is very suggestive of the acini of a racemose gland. A similar arrangement is visible in the corresponding scent-patch of *Catopsilia pyranthe* Linn.

On the underside of the forewing in *C. florella*, the specialised scales take the form of long hairs which are collected into a flattened fringe or tuft lying along the inner margin of the wing, and covering the scent-patch of the hindwing in the ordinary position of rest. The region of the wing occupied by these hairs is also well supplied with tracheal branches, whose

terminal twigs seem to bear a special relation to the sockets of the hairs.

Whether in any of these cases the ultimate tracheal ramifications anastomose, I am unable to say. The appearance in *Teracolus fausta* is strongly suggestive of anastomosis, but I find no absolutely clear evidence on the point. The finest terminal twigs are not easily traced, and even the larger capillaries, unless they happen to contain air, can only be followed out with considerable difficulty.

The significance of the special distribution of tracheæ to the scent-patches and hair fringes is a matter of conjecture, but that it has some reference to the scent-producing and scent-distributing function of these structures seems certain. It is noteworthy that the fringe of hairs in *C. florella*, which is free from any admixture with scent-bearing scales like those of the patch on the hindwing, is nevertheless well furnished with air-tubes; and the suggestion may be hazarded that their presence may assist in some way the erection of the hairs or the dispersal of the perfume. But in any case their entire absence, so far as has been observed, from the scent-patches in *Acmepteron* and *Dismorphia*, is not easy to explain.

Some of the points dealt with in the present paper have been noticed by FRITZ MÜLLER, and reference may be made to the English translation by Mr. E. A. ELLIOTT of his Papers on the Scent-organs of Lepidoptera, lately published by Dr. G. B. LONGSTAFF as an appendix to his book *Butterfly-hunting in Many Lands*.

The paper was illustrated by lantern slides of most of the structures described.

ON VIVIPARITY IN POLYCTENIDÆ.

By K. JORDAN, TRING.

(Text-figs. 9, 10, 11.)

THE methods of the production of offspring in insects may be classified under the two headings Oviparity and Viviparity. In the former case the offspring leaves the ovary and body of the mother as an egg from which the larva emerges after oviposition, while in viviparous insects the offspring is deposited as a larva or a chrysalis. Viviparity, however, really comprises two very different kinds of reproduction. In Gonochetal Pregnancy (HEYMONS) the ovary produces an egg which is retained, in the oviduct until it has ripened into a larva or even a pupa. This may occasionally also happen in insects which are normally oviparous. In Ovarial Pregnancy, on the other hand, the germ remains in the ovarian tube where it originated, and gradually matures here into a larva without an intermediary egg-stage. Ovarial Pregnancy is comparatively very rare. It is known to occur among Aphides, Cecidomyiids, Chrysomelid beetles, etc., the best and perhaps most interesting example being that of *Hemimerus*, the peculiar blind, aberrant earwig which is found in Africa on *Cricetomys gambianus*, a kind of rat. According to HEYMONS (1909) the ontogeny of *Hemimerus* is distinguished by the absence of yolk from the egg-cell, and the presence of an amnion by means of which the embryo derives nutriment from the surrounding tissues of the ovarian tube, this method of nutrition of the embryo being unique among insects. At a later stage, when the embryo changes from the inverted position (ventral side convex and dorsal side concave) into the imaginal position (ventral side concave and dorsal side convex), the amnion disintegrates and is replaced, functionally, by a special organ projecting from the neck, the *vesicula cephalica* (HEYMONS), which osmotically sucks up the disintegrating

tissues of the ovary, and passes them on to the embryo as nutriment.

The cases of viviparity known among insects have been enumerated by HOLMGREN in 1903. We can add an additional example of Ovarial Pregnancy, which may be expected to turn out to be as interesting as that of *Hemimerus*, and which occurs in the parasitic *Rhynchota* called *Polyctenidæ*. After the discovery of Viviparity in one species of this family, all the other species available were examined, and we are now convinced that Ovarial Pregnancy obtains in all as the only kind of reproduction.

The *Polyctenidæ* are parasitic on bats, and occur in the tropics of both hemispheres, but none have as yet been found in Australasia. On account of their small size, the density of the fur of their hosts, and the habit of keeping close to the skin of the host, these parasites appear to be easily overlooked, and therefore are rare in collections. Occasionally specimens in various stages of immaturity are obtained together with adults on the same individual of the host. In some instances the abdomen of a female was found to be nearly empty, apart from the gut. The internal anatomy is still entirely unknown. Most of the specimens which we have studied—and which belong to the British Museum—were glued on cards, but are now properly mounted in balsam, while others are preserved in alcohol.

The family is closely allied to the bed-bugs, with which they have many peculiarities in common. The species are characterised by the possession of one or more combs of short, flat spines, an armature which they share with some other groups of ectoparasites, e.g. *Siphonaptera*, *Nycteribiidæ*, and *Platy-psylla*. Unlike *Hemimerus*, the immature stages of the *Polyctenidæ* differ more or less strongly from the adult in the armature of the exoskeleton. The earlier writers on the subject were not aware of this fact, and therefore several errors crept into the systematics of the family. The first-described species, *Polyctenes molossus*, was based on two specimens, one a mature male, erroneously considered to be the female, the penis being mistaken for an ovipositor, and an immature example erroneously described as an immature male. *Eoctenes spasmæ* Waterh. (1879) was founded

on two individuals which, on re-examination, have proved to be immature examples of the species described in 1898 by SPEISER as *talpa* from adult individuals. Such errors are readily excusable in a group of which nothing or very little was known at the time. The proof that the immature and adult stages differ in the development of the combs was brought by SPEISER, who discovered under the skin of a nymph of *Eoctenes spasmæ* Waterh. (1879) a comb on the pronotum and elytra, while the nymph itself had no comb in these places, the nymph bearing one dorsal comb (the nuchal one), and the imago forming in the nymph having three. Further evidence was accorded to us by the discovery of an embryo in an advanced state of growth in a female of the African *Eoctenes nycteridis* Horv. (1910). The female containing the embryo was unfortunately glued on a card, and the embryo is consequently so much shrivelled that only the more strongly chitinised parts can be made out clearly. Moreover, large portions of the embryo are rendered invisible, or are much obscured, by blotches of the blood the mother has been sucking. In our figure, therefore, only those parts are outlined which are more or less distinct. Most of the bristles, however, have been left out, though they are clearly visible in the specimen (text-fig. 9).

An examination of a number of females of various species, either mounted in balsam or preserved in alcohol, has revealed several embryos and has rendered it certain that the embryo remains in the ovary until it is born. There are apparently very few ovarian tubes (two or three on each side), and each contains only one embryo, as in the case of *Hemimerus*. The embryo reaches such a size that it almost fills half the abdomen of the mother, and only one appears to become mature at the time. The position of the left hindtarsus close to the anus of the female renders it probable that the particular specimen figured was on the point of being born when the mother was caught and killed.

As will be seen from the sketch (text-fig. 9), the head of the embryo is bent ventrad as in *Hemimerus*, its undersurface lying on the breast and the apex being directed anad. In the figure the upper- and undersides are combined. The various organs of the head can clearly be distinguished in the embryo,

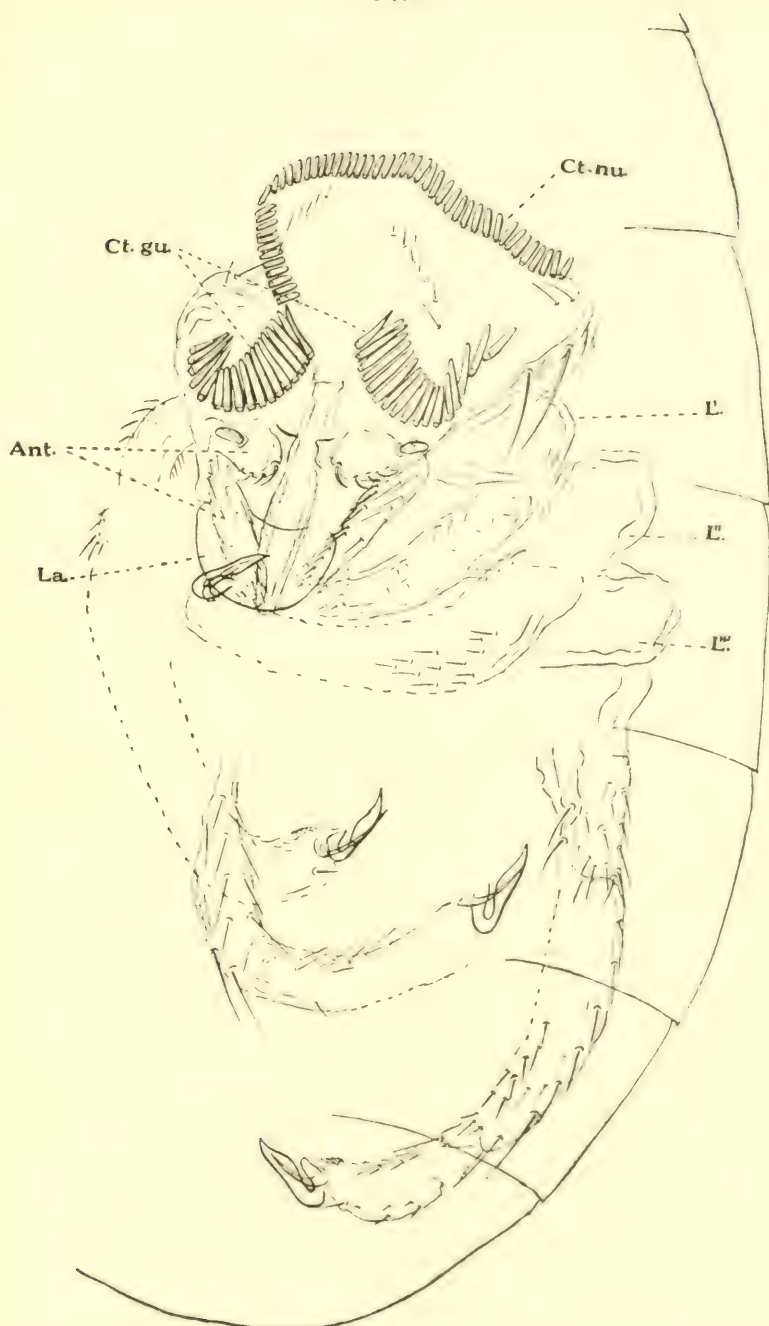


FIG. 9.—Embryo of *Ectenes nycteridis* Horv. Ant., antenna; Ct. gu., gular comb; Ct. nu., nuchal comb; La., labrum; L', L'', L''', legs.

agreeing on the whole with those of the mother, but the head appears proportionately longer. The anterior section (La) of the head is generally described as the *clipeus*, but we are now convinced that it really corresponds to the upper lip (*labrum*) of the bed-bug. This labrum appears decidedly longer than in the adult, but that may be due to the sides being bent down. The upperside of the head bears in the embryo and the imago two oblique rows of bristles converging posteriorly, and an apical comb of spines. The right-side portion of the head of the dried-up embryo is much curved down, which accounts for the position of the corresponding portion of the nuchal comb in our figure. The number of spines in this comb (Ct. nu.) is the same as in the imago (48).

The proboscis stretches forward, and consists of three segments, as in the adult examples of this species, the apical segment being much the longest. The antennæ (Ant) also are directed forward with the exception of the first segment, which has the same position as in the adult, being directed laterad. The armature of the first antennal segment differs markedly from that of the adult. This segment has in the imago a subapical transverse row of spines, a longitudinal row of smaller spines near the anterior edge, and a row of curved bristles at this edge. These bristles are present in the embryo, but the longitudinal comb is entirely absent, and the subapical one is only represented by a single spine.

The two half-rings of the gular comb (Ct. gu) are very distinct, each consisting of eighteen spines, as compared with nineteen or twenty in the nymph, and twenty-two in the imago.

The prothorax and the elytra—which both have an apical comb in the imago—are so much obscured that I cannot make out their outlines, but so much seems certain that they do not bear combs in the embryo, as these would show at one place or another on the slide.

The claws of the tarsi are as strongly chitinised as the spines of the combs, and therefore stand out fairly clearly.

In *Nov. Zool.*, 18, t. 13 (1911), we figured an immature example which we consider to be the nymph of *Eoctenes nycteridis*. The specimen differs from the adult—apart from the bi-articulate mid- and hindtarsi and some other larval characteristics—

particularly in the absence of the pronotal comb and the smaller number of teeth in the elytral comb. In the ontogeny of this species the sequence of appearance of the dorsal combs therefore is this: (1) nuchal comb, (2) elytral comb, and (3) pronotal comb. We may infer from this fact that the combs appeared in the same order in the phylogeny of the species, a conclusion at which Dr. SPEISER also arrived from a comparison of the nymph and imago of *Eoctenes spasmæ* (= *talpa*).

Does this sequence hold good for all *Polyctenidæ*, and have those species which in the imago state are devoid of one or more dorsal combs lost these combs, or have they never acquired them? The ontogeny might possibly throw some light on these questions. A comparison of the few immature individuals which we have with the imagines warrants but few generalisations as to the phylogenetic sequence of the combs, as a brief survey will prove.

The nymph of *Polyctenes molossus* has only a gular comb, which is smaller than in the imago, the apical margins of the head and pronotum bearing no combs, whereas the imago has a nuchal and pronotal comb. There is no elytral comb in this species.

In *Eoctenes spasmæ*, of which there is a pregnant female in the collection of the British Museum, the embryo as well as the nymph (*i.e.* presumably all the larval stages) have a gular and a nuchal comb, both being in the embryo still as pale as the rest of the body, the imago bearing in addition a pronotal comb and an elytral one.

In *Eoctenes nycteridis*, as we have seen above, the embryo has gular and nuchal combs, the nymph in addition an elytral one, and the imago, besides these, a pronotal comb.

The American *Hesperoctenes* are devoid of dorsal combs of blunt spines, the gular one is present in the imago and all larval stages except the specimens which I believe to have been collected soon after their birth. In these young *Hesperoctenes* (text-fig. 10) we observe a most puzzling phenomenon. The gular comb, which is already so well developed in the embryos of the Old World *Polyctenids* (as far as embryos are known of them), is entirely absent from the very young *Hesperoctenes*, but a comb exceedingly similar to half a gular comb is present on the first antennal

segment. The similarity is so striking that on a cursory examination of the young *Hesperoctenes* I did not at once notice that the two halves of the comb were placed on the two antennæ instead of on the underside of the head. This comb disappears in the next moult, or rather, is replaced by small spines directed distad. One of the individuals with such an antennal comb shows already under its skin the true gular comb of the next stage in the metamorphosis of this specimen. These observations are of some weight, inasmuch as they prove that an organ so persistent as the gular comb—which is present in all the

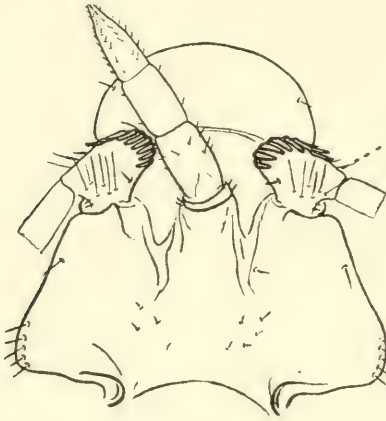


FIG. 10.—Head of larva of *Hesperoctenes impressus* Horv., underside.

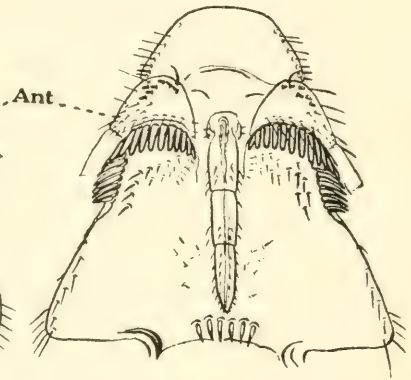


FIG. 11.—Head of male of *Hesperoctenes impressus* Horv., underside.

known *Polychtenidæ*, adult and immature, with the exception of that one early larval stage of *Hesperoctenes*, even being present if the dorsal and antennal combs are all absent, and therefore might be regarded as a more ancient acquirement than the other combs—is not necessarily everywhere the first to appear in the ontogeny of the species of the family, and, inversely, that the organ appearing first in the ontogeny of some of the species is not necessarily to be considered as phylogenetically older for the family than homologous organs which appear at a later ontogenetic stage. However, we may nevertheless assume that in the ancestral *Hesperoctenes* the antennal comb was the first to appear, and in the ancestral *Polychtenes* and

Eoctenes the gular comb. This assumption means that *Hesperoctenes* branched off when there was as yet neither a gular nor an antennal comb. Another possibility is that the antennal comb of the young *Hesperoctenes* is the phylogenetically oldest one in the whole family, and was transferred in the next phyletic stage to the head and replaced on the antenna by small spines directed outward. In this case we must consider *Hesperoctenes* as having preserved an ancestral stage which has been dropped by *Polyctenes* and *Eoctenes*. Whichever alternative we may favour, *Hesperoctenes* appears in either case as an ancient branch of the family. The symmetry of the tarsal claws and the more normally developed anterior tarsus in *Hesperoctenes* are further evidence that this American genus is more ancestral than the Old World genera of *Polyctenidæ*. Does the absence of dorsal combs in *Hesperoctenes* point in the same direction? The spines of the combs are modified bristles. Their place is taken by bristles in the immature stages if a comb is restricted to the adult, and the same is the case in the adult *Polyctenids* if a comb is absent in the respective species. In *Adroctenes* we meet with all intergradations between a pointed bristle and a blunt spine. In the metamorphosis of the *Polyctenids* we only observe an increase in the number of combs and number of spines in the combs, nowhere a decrease, apart from the comb on the first antennal segment of the young *Hesperoctenes*. This may be taken as evidence that also in the phylogeny of the family an increase in the combs took place. On the other hand, we have no evidence of any kind for a decrease in the number and size of the dorsal combs. It is therefore highly probable that the species with three dorsal combs are (in this respect) younger than the species with two or no dorsal combs, *Hesperoctenes*, without such combs, but with a nuchal row of bristles, being the most ancestral. No adult *Polyctenid* is as yet known which bears only one dorsal comb of blunt spines. If such a species exists, it will presumably be the nuchal comb which is present.

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PELLETS EJECTED BY INSECT-EATING BIRDS AFTER A MEAL OF BUTTERFLIES.

By C. F. M. SWYNNERTON, CHIRINDA.

PROFESSOR POULTON read a communication by C. F. M. SWYNNERTON, F.E.S., contained in the following letter, written June 27th, 1912, from Chirinda, Gazaland, S.E. Rhodesia. Professor POULTON also exhibited the pellets referred to, together with set examples of the butterflies named.

"I am sending you by this mail a few pellets that have been ejected by birds. Those pellets that are intact—from *Dicrurus afer* Licht. (African Drongo); *Lanarius starki* W. L. Schl. (Southern Grey-headed Bush-shrike); *Lanius collaris* L. (Fiskaal Shrike)—contain no butterfly remains. I merely send them in case you should be interested to see the pellets of Passerine birds. The other pellet from *Dicrurus afer* Licht. (African Drongo), ejected October 12th, 1911, does contain butterfly remains. I have just examined a portion of it in order to get an idea as to what sort of a sample I was sending you, and it does not strike me as being as good as many that I have seen. Even here, however, it seems to me that any one unused to the appearance of butterfly remains in pellets and making an examination, especially a rough one, with the naked eye, might well fail to recognise a considerable portion of the débris. Put it, however, under a lens strong enough to show the scales and sockets, and the difficulty vanishes. This particular pellet should contain the remains of twenty-six butterflies and eight flies.

"The flies were:

One *Tabanus* sp. nov. (my No. 3,689, sent to GUY MARSHALL).

Five *Hæmatopota sanguinaria* Aust. (At first determined as this species by Mr. E. E. AUSTEN, but

later considered by him to be a distinct species still undescribed.)

Two *Cadicera biclausa* Loew (my Nos. 3,683 and 3,684, sent to GUY MARSHALL).

“The fifteen butterflies that were swallowed, wings and all, were :

Seven *Mycalesis campina* Auriv.

Two *Neptis agatha* Stoll.

Three *Pyrameis cardui* L.

One *Precis orithya* L. v. *madagascariensis* Guen. (= *boopis* Trim.).

One *Papilio demodocus* Esp. (hindwings only : head and front of thorax also not swallowed).

One *Rhopalocampa libaon* H. H. Druce.

“The eleven that were eaten without wings were :

One *Precis cebrene* Trim.

Three *Precis octavia* Cram. var. *geogr. natalensis* Staud. dry season f. *sesamus* Trim.

One *Precis tugela* Trim.

Two *Precis artaxia* Hew.

Two *Pyrameis cardui* L.

One *Pseudacraea lucretia* Cram.

One *Charaxes pollux* Cram.

“You have the entire pellet (I lost at the most only a few scales in examining a portion of it), yet I *doubt* whether you could easily find in it evidence of the bird having shortly before eaten all these Lepidoptera and Diptera ; yet the pellet represents the whole evidence (unless the intestines were also examined) that a man who shot the bird shortly before it was ejected would have had to go on.

“Small grasshoppers had been eaten just before the experiment, and are also represented in the pellet. I also send another smaller pellet of the same date, containing grasshopper débris. I presumably kept it to compare with the one containing butterflies. I have no note to show whether it came before or after the latter.

“I have practically never troubled to keep the pellets after a butterfly experiment, but might easily do so, should you think

it worth while. Thus an interesting and convincing exhibit might be made of the contents of, say, a dozen pellets, representing a dozen species of birds. In each case Coleopterous remains might be placed in one row, Orthopterous in another, butterfly-remains in another, and so on, and beside each might be placed the complete insects, set, to indicate the relative amount of disguise that had taken place.

"While writing the above it struck me to hunt up a pellet of *Coracias garrulus* L., brought up during an experiment on April 2nd of last year. I see the envelope is undated, but my recollection with regard to it seems pretty clear, apart from the fact that this was, I feel sure, the only pellet belonging to this particular roller ('C') that I have kept. I thought, I remember, that it might be interesting to examine it some day, but am sending it to you intact, as I think that, if the butterfly-remains in it are at all typical of what I have usually seen, you will find it more interesting and convincing to have broken it up yourself. Before doing this (breaking up) I find it best to let the pellet absorb water freely. The small wing fragments are then most easily detected by placing a small fragment of the pellet at a time in a few drops of water; many of them float. The appearance of the wing-veins is often interesting—mere fragments of rods with little or, often, no membrane attached.

"I am also sending you a pellet of *Bucorax caffer*. I have no idea what it should contain, apart from what can be seen on the outside, but as it forms one of a number collected with a view to throwing light on the food of my unconfined ground-hornbills, either its contents or a note of them should be kept. I am sending it because I see that it contains fairly typical remains of Coleoptera, and I think you will like to compare these with those of the butterflies, grasshoppers, and flies contained in the other pellets sent.

"I had nearly forgotten to say that the roller 'C' had eaten, just before bringing up the pellet referred to above, several grasshoppers, one *Melanitis leda* F., two *Hypanartia schæneia* Trim., one *Precis antilope* Feisth., one *Precis artaxia*, one *Charaxes zoolina* Doubl.-Hew., one *Tagiades flesus* F., one *Rhopalocamptia forestan* Cram., one *R. libaon* Druce, one *Papilio nircus* L. v.

lyæus Doubl.—ten butterflies in all, each of them swallowed wings and all.

“So far as the 40,000 American birds’ stomachs are concerned, *if* they were microscopically and thoroughly examined, then they constitute a very damaging argument. If they weren’t, then the results of their examination are valueless in relation to this particular discussion. MARSHALL has re-examined more than one hundred of my bird-stomachs and, I believe, found no additional lepidopterous remains, but I do not know whether he looked for mere scales. I re-examined three during the past week (all I had time for) and found remains of Lepidoptera in two of them (*Erithacus swynnertonii* Sharpe, the Chirinda Robin, and *Merops apiaster* L., the European Bee-eater). In the case of the robin I had carefully examined several fields under my little microscope before I found the first scale, and it was only right at the end that I found several more, as well as several minute wing-fragments, such as I have commonly found in pellets. This shows the need for an absolutely *exhaustive* examination of each stomach.

“You are, of course, welcome to utilise the pellets I send as you wish. Should you find them good as instances of disguise you may care to show them or quote them when writing on the subject.”

ON THE PHYLOGENETIC SIGNIFICANCE OF THE WING-MARKINGS OF RHOPALOCERA.

By J. F. VAN BEMMELEN, GRONINGEN.

(Plates XXXII–XXXIV.)

INTRODUCTION.

TWENTY-TWO years ago, at an assemblage of the Dutch Congress for Science and Medicine, I read a paper on my investigations into the development of the colour-pattern and the neurulation of the wing in the chrysalis of *Vanessidæ*. These investigations had led me to the following conclusions:

The colour-pattern of the imaginal wing arises rather suddenly during the last days of the pupal period.

Notwithstanding this each colour needs a certain lapse of time to reach its full intensity; the whole aspect of the phenomenon consequently reminds one of the gradual appearance of a photograph in the developing-bath.

The different colours do not appear simultaneously, black coming some twenty-four hours after the others. Yet from the moment of their first appearance they occupy the same areas filled out by them in the full-grown pattern.

Accordingly the parts destined to become black are left blank during the foregoing development of red, yellow, or brown.

Neither radiation from centre of first appearance nor trespassing of one colour on the dominion of a neighbouring one occurs.

But these rules only apply to the components of the definite imaginal pattern. This pattern, however, is preceded by a very different one, which arises soon after pupation, and remains practically almost unchanged up to the sudden manifestation of the imaginal one. We may call it the original or primitive pattern. In *Pyrameis cardui* it consists of a cinnamon-brown

ground-colour and a series of light spots, one in each marginal wing-cell or internervural space. The ground-colour shows itself somewhat earlier than the spots, and the forewing precedes the hind one in the development of both colour and markings (fig. 1).

When the definite pattern makes its appearance the primitive one is merged into it, and obscured by it, but some of the marginal light spots pass from the one into the other.

These remnants of the original or pupal pattern are precisely the characteristic spots common to different members of the *Vanessa* family, and occur in all grades of distinctness, size, and number, from *Junonia laomedea* or *Precis hellanis*, which show them nearly all, to *V. urticæ*, where only the foremost one on the forewing is preserved. Generally speaking, they disappear from behind forwards, and are often more visible on the under- than on the upperside.

Very shortly after the publication of my paper, and quite independently of it, appeared the admirable article of my honoured friend Dr. DIXEY on "The Phylogenetic Significance of the Wing-markings in the Nymphalidæ," in which, in the first place, he called attention to that same row of marginal spots which I have just mentioned, and convincingly proved its great significance for the systematic and phylogenetic arrangement of the *Vanessidæ*.

In my article of 1889 I had moreover mentioned the fact that this row of light-coloured marginal spots, as far as it occurs on the forewing, was also visible on the wing-sheath of the pupa, and that the same was the case with certain other features of the primitive forewing-pattern, *e.g.* the division of the ground-colour into a lighter external and a darker internal area, which is peculiar to the developing wing of *V. urticæ* (figs. 2 and 3). In this respect I found that I was in perfect agreement with the views of the distinguished president of this Congress, laid down in his classic papers "On the Morphology of the Lepidopterous Pupæ, its relation to that of the other stages and to the origin and history of Metamorphosis," which appeared in 1890 and 1891.

In these papers he brought forward strong arguments in favour of the proposition that the pupa should not be con-

sidered as a mere transitional stage between the larva and the imago, but as an independent organism, much more nearly related to the butterfly than to the caterpillar, and having preserved in its structure many primitive and archaic characteristics that are of great value to us for the interpretation of the imaginal features. POULTON even gave an enlarged and accurate drawing of the wing-sheath of the *Vanessa polychloros* pupa, in which some of the light marginal spots can be easily recognised, but without paying further attention to this colour-pattern; his interest being especially directed to the important vestiges of diminution in size and change in form of the forewing.

During the long time that has elapsed since the publication of my first paper, an immense number of articles dealing with the wing-development and the colour-patterns of Lepidoptera have appeared.

I need only mention the names of EIMER, FICKERT, E. FISCHER, E. HAASE, JORDAN, VON LINDEN, A. C. MAYER, NEWBIGIN, PIEPERS, ROTHSCHILD, SPENGEL, SPULER, STANDFUSS, STAUDINGER, TOWER, URECH, to hold myself excused for not even trying to give you a sketch of the different methods applied to the investigation of this interesting question and the conclusions to which they have led.

Yet, I venture to say, the problem is by no means solved, and so great a diversity of opinions prevails that there is every reason for returning to the subject. I even believe myself justified in saying that, had the method indicated by me in 1889 been more generally applied, we should now stand on firmer ground and have made greater progress in the understanding of the phylogenetic relations between races, species, genera, families, and even orders of Lepidoptera.

It is but fair to acknowledge, however, that the Countess VON LINDEN has indeed taken this course and has published an elaborate and exact paper on the wing-development of rather a large number of diurnal Lepidoptera, without, however, having come to my conclusions as to the occurrence of a primitive pattern which is common to the different species of one and the same genus or family, and which in passing into the definite pattern is more or less effaced, altered, restricted to the underside, or otherwise obscured.

The cause of this disparity between my conclusions and those of the Countess VON LINDEN may, as far as I can see, be found in two circumstances: firstly, Dr. VON LINDEN seems not to have paid sufficient attention to the younger stages in the wing-colour development; and secondly, she was handicapped by her conviction of the correctness of EIMER's hypothesis about the primitive nature of longitudinal striping in different classes of animals.

Returning after so many years to the study of this interesting subject, I have extended my investigations to the families of *Pieridæ* and *Papilionidæ*, and paid more attention to the external appearance of the pupal sheath. Taking the point of view indicated by POULTON about the real nature of the chrysalis, we may by its help get to a series of developmental stages of the wings, at least of the forewings. With regard to the succession in time of their appearance, they are the following:

1. The uncoloured wing-rudiments in the full-grown caterpillar.
2. The wing-sheaths of the newly formed pupa.
3. The wing-sheaths of the fully coloured pupa.
4. The uncoloured wing-rudiments within the young pupa.
5. The newly coloured wings within the pupa, showing the so-called primitive pattern.
6. The different stages of the definite pattern.

This succession in time need not, however, necessarily correspond with the real morphological sequence of patterns on the wings.

On the contrary, the colour-pattern of the wing-sheath of the chrysalis undoubtedly represents a farther advanced degree of development than the primitive coloration of the wing-rudiments within this sheath. We are thus, by studying the colour-pattern, led to the same conclusion as POULTON arrived at for the wing-size and form, and (using his own words) "for the venation of the wing-sheath in comparison with the course of the main tracheæ of the pupal wing, which will ultimately be enclosed as important elements in the imaginal veins, and which at this time possess an arrangement different from that which they will then assume." This conclusion may be thus formulated: that the ornamentation of the pupal wing-sheath

gives us a picture of the wing-pattern of a certain ancestral stage, but not of the most primitive one.

This same stage is also repeated by the developing wings under the pupal covering, but here it bears only a transitory character, as it finally passes into the definite pattern of the imago. As said above, the latter arises rather suddenly, and from the beginning all its component markings show their ultimate shape and boundaries. In this instance it resembles the pattern of the pupal sheath, which also arises in a very short lapse of time, and is at once finished in all its details.

We may therefore conclude that this pupal pattern has possessed its antecedent stages as well as the imaginal one, and that these stages probably corresponded to the first vestiges of colouring on the developing wings, which precede the full display of what I call the primitive pattern. In the case of the pupal wing-sheath these precursory stages must be compressed into a few hours, partly before and partly after the ecdysis leading to the appearance of the pupa. This fact justifies the *a priori* assumption that they will not manifest themselves very clearly, and do not lend themselves well either for fixation or for observation. What I saw of them during the exuviation of the caterpillar's skin confirms this supposition: the young wing-cases are transparent and show only very faint traces of coloration.

In both these features they differ from the colouring of the body, especially the abdomen, which possesses a richly developed pattern of different shades. This latter pattern corresponds in its outlines, and also to a certain degree in its colour-shades, to that of the full-grown caterpillar under whose skin it has developed. POULTON seems to ascribe this first coloration of the pupa to "the larval pigment still lingering unchanged in the pupal hypodermis cells," and therefore "of no morphological significance." I have not yet found leisure to extend my investigations to the colouring of the body and appendages other than the wings, but I believe that this study will yield interesting results, and I presume that the above-mentioned first and transient coloration of the pupal body has a deeper significance than meaning only a mere lingering behind of the caterpillar's pigmental distribution. I was very

much impressed by the fact that in the newly formed pupa of *Vanessa urticæ* and *io* there exists a conspicuous difference between the colour of the sheaths for the wings, antennæ, tongue, and other imaginal organs, and that of the rings of the abdomen and the tergites of the thorax. The former were almost colourless, the latter had a complicated and vividly pigmented pattern.

I should wish to make a few preliminary remarks on the slides I am now going to show you. They are made from photographs taken from the pupæ themselves with a magnifying lens, the photographs serving me as sketches on which I have retouched with ink those details that I wished to bring into evidence, but always under proper control, the original objects lying before me under the binocular microscope.

Now, in connection with these drawings of pupæ, I may perhaps be allowed to draw your attention to the scantiness of figures relating to pupæ and even to larvæ of Lepidoptera. Not being an entomologist myself, and not having at my disposal large collections of insects, I had to recur to the existing illustrated works, and I must say that, with the exception of Prof. POULTON'S excellent drawings of different morphological details of chrysalids, I have not been able to find any sufficient number of good figures that were of the least service to me. It goes without saying that simple drawings in natural size, however artistically or faithfully done, are not of the slightest use, either for the study of structural details or for the colour-pattern.

DESCRIPTION OF THE WING-SHEATH OF *V. URTICÆ* (figs. 2 and 3).

Three peculiarities attract our attention :

1. The division of the outer part into two fields by a dark bar running in a diagonal direction from the costa or top of the middle cell to the obtuse hinder (or inner) angle of the wing. The anterior border of this bar is sharply defined, and stands in strong contrast to the anterior wing-field touching it, this latter being of a much lighter tone of grey. Towards the side of the anterior wing-border, and towards the base of the wing (that is to say, in an antero-proximal direction), the sharp anterior border of the bar is prolonged by a strip of dark

pigment marking the course of the anterior discoïdal vein, mentioned below (sub 2). Towards the hinder border, on the contrary, the dark bar passes imperceptibly into the general ground-colour of the wing-surface.

By this difference between the two sides of the diagonal bar, a contrast is brought about between the halves of the whole wing. The inner and hinder half shows a much darker aspect than the outer and anterior one, though neither of these fields is equally shaded over the whole of its surface.

The anterior field darkens towards the apex of the wing, which itself is again of a lighter hue ; the posterior field, on the contrary, becomes lighter towards the base of the wing.

2. The occurrence of a ∇ -shaped dark figure on the discocellular vein, which is the outer part of the black circuit-line bordering the middle cell, next attracts our attention. The anterior arm of this ∇ forms a prolongation of the above-mentioned bar up to the neighbourhood of the anterior edge of the wing. From the outer side of the ∇ four or five dark lines, marking the bases of as many marginal veins, radiate towards the distal side.

3. Two parallel series of light-coloured spots are arranged transversely over the outer part of the wing-field. The outer series marks the denticulated margin of the imaginal wing discovered by POULTON. Both series comprise nine or ten spots, which are situated in the middle of the spaces between the veins. The eighth and ninth form a pair, the distance between them being shortened in consequence of the reduction of the first anal vein, which passed between them.

The inner series corresponds with the above-mentioned submarginal spots of the primitive pattern on the developing imaginal wings.

A certain difference in size and form, which also occurs among these latter, likewise may be observed among the pupal spots. The anterior one, *e.g.*, is larger and more oblong than the following spots, but less sharply delineated ; the sixth and seventh are larger than the preceding 2 to 5.

At the inner or proximal side of the spots, three to five irregular figures of dark pigment are seen, reaching to near the inner end of the marginal wing-cells, whose median area is occupied by them.

They begin broadly at the inner border of the light spots, and become thinner as they run out towards the discocellular vein. The fourth and fifth of these black stripes are the largest. A similar pigmented figure belonging to spot 2 is hardly conspicuous, a fact easily explained by the small extension of the fork-cell, in which this spot is situated. These accumulations of spider-like black pigmented markings are also present at the inner side of the remaining light spots, but they are here less sharply circumscribed and do not stand out so conspicuously against the darker ground-colour of the posterior wing-area.

The spots of the marginal series are triangular in shape, their rounded bases being turned towards the side of the outer edge of the wing. The sides of these triangles are edged with black, which colour passes imperceptibly into the dark pigmented markings of the outer parts of the wing-fields. The thin, sharp groove marking the course of the imaginal wing-border often passes through the middle of one or more of these marginal white spots.

The spots of the outer series correspond exactly to those of the inner series; spots 8 and 9 are again united to form a pair.

COMPARISON OF THE PUPAL SHEATH OF *V. URTICÆ* WITH THAT OF *V. IO* (fig. 4).

Each of the three above-mentioned characteristics of *V. urticæ* is also found on the pupal case of *V. io*, though its general aspect is rather different. Dark pigmentation is much less developed, and the whole surface of the wing-sheath is far more smooth, which renders the two rows of light spots almost inconspicuous. Yet it is easy to find also here both series of light spots to the same number, and similarly arranged as in *V. urticæ*. Especially those of the inner row give one the impression of convex transparent areas of the chitinal cuticle, bulging out a little over the surrounding surface.

This aspect of the spots possibly may have a deeper meaning, to which we shall presently return when we speak of the *Pieridæ* and *Papilionidæ*.

Though the amount of black pigment is so considerably

lessened, the concentration to spider-like figures filling in the interveinal cells, especially the three cells 3 to 5, at the inner side of the internal row of spots, perfectly agrees with what is found in *V. urticæ*. This is likewise the case with the diagonal bar, the v-shaped top of the middle cell and the course of the wing-veins being marked by transverse stripes of black pigment.

WING-SHEATH OF PAPILIONIDÆ.

Turning our attention to the *Papilionidæ*, we meet a highly instructive object in the black and yellow variety of the pupa of *Papilio machaon* (fig. 5). In this the amount of dark pigment is much more considerable than in the green variety, and so its distribution can easily be studied. It is noticed at a glance that the same arrangement prevails as in the *Vanessidæ*: the pigment is partly concentrated along the course of the wing-veins, the rest filling in the interveinal wing-cells. The former has especially accumulated along the inferior discocellular vein and the bases of the four marginal veins radiating from it. The v-shaped top of the middle cell is likewise present, though the v is not nearly so well defined as in the *Vanessidæ*. Unlike the pigment of the veins, which diminishes towards the outer edge of the wing, that of the interveinal spaces goes on increasing, thereby causing a dark marginal fringe to be present along this border. It is easily seen that this fringe is composed of as many triangular spots as there are interveinal marginal spaces. The triangles even show a darker central part springing from a light spot in the middle of the basis.

These spots remind us, in respect of place and aspect, of the outer series in *Vanessidæ*, the inner series, on the contrary, not being visible in *P. machaon*.

Another feature distinguishing the *Papilionidæ* from the *Vanessidæ* is the occurrence of a second marginal series of spots, alternating with the first and therefore situated at the end of the wing-veins. These latter spots are somewhat larger and more convex than the interveinal ones, and consequently appear raised above the wing-surface as brilliant lens-like knobs. In a few other species of *Papilionidæ*, whose dried pupæ stood at my disposal, the lustre and size of these knobs

was still more considerable than in *machaon*. This led me to ask if we might not be justified in regarding these knobs as something more than a mere ornamentation, viz. the rudiments of sense-organs for the perception of light. Should this hypothesis prove to be well founded, then the same might perhaps be assumed for the inner series of spots in *Vanessidæ*, though here the regression from the original functional structure must have reached a far deeper level.

I have not yet been able to test the probability of this suggestion, but I wish to point out that PH. VOGEL, in his paper on the distribution of the sense-organs over the wings of the Lepidoptera, *Zeits. Wiss. Zool.*, xcvi (1911), indicates the presence of "Sinneskuppeln" along the course of the veins and especially at their outer ends, where they meet the lateral wing-border.

Papilio podalirius (fig. 6).

Though the general aspect of the wing-cases of *podalirius* is remarkably different from that of *machaon*, they are in fact built and ornamented on the same principles, and show the same peculiarities.

The net of the wing-ribs is conspicuous by reason of its light colour against the darker brownish tint of the remaining wing-surface. Though at first sight one might think that this ground-colour was very evenly distributed, it is not difficult to distinguish triangular interveinal marginal areas of a somewhat darker hue. In the middle of the base of each triangle a small twig-like knob sprouts inward from the marginal vein, and outward into the interval separating the margin of the imaginal wing from that of the pupal.

Thais polyxena (fig. 7).

It seems to me a remarkable fact that, while there exists a considerable difference between *P. machaon* and *podalirius*, the wing-sheath pattern of the former is repeated almost to identity on the pupa of *Thais polyxena*. This fact I consider as an important proof of the deep significance of this pattern.

PIERIDÆ.

Pieris brassicæ (fig. 8).

Of the four species of *Pieridæ* whose pupæ I was able to study, *P. brassicæ* seems to me the fittest to prove the fundamental identity of the wing-sheath pattern in different families of Rhopalocera. The dark pigment is restricted to the course of the veins and the median stripes of the interveinal spaces.

Along the veins the black pigment is distributed at unequal distances in isolated rounded spots of different size, which, towards the outer margin, get more alike and become arranged in parallel transverse rows. The interveinal pigment, on the contrary, is concentrated in numerous irregular little ripples, mostly running transversely, and more or less arranged in the grotesque, spider-like markings already known to us from the *Vanessidæ*. These markings nearly fill in the whole space of the wing-cells, no inner series of light-coloured, polished spots being discernible. In another point, however, the pupa of *P. brassicæ* shows a certain likeness to that of both *Nymphalidæ* and *Papilionidæ*: its lateral wing-margin (along the borderline of the imaginal wing) bears a row of triangular black spots, situated between the veins. These spots may be considered as homologous to the pigment-accumulations around the white marginal tubercles of the *Vanessidæ* and the *Papilionidæ*; these latter structures themselves being absent in the *Pieridæ*, as is also the inner series of light spots.

That the latter may have been present in the ancestors of *Pieridæ* is rendered probable by the wing-sheath of *Gonepteryx rhamni* (fig. 9). In the light-green ground-colour of this pupa, a faint pattern of darker pigment may without difficulty be distinguished, especially in the first hours after exuviation. The pigment-arrangement in the wing-cells bears a great resemblance to that of *P. brassicæ*, but that along the veins is almost absent. At a certain distance from the imaginal wing-margin, however, the dark pigment-figures end with a faint concentration around a light centre: our inner marginal series of light spots! The same phenomenon is repeated at the above-mentioned margin itself: here also the dark interveinal spots show a lighter centre. A similar dark, circumscribed mark, even more conspicuous than

the foregoing, is found on the base of the discocellular vein, *i.e.* the point of the v-figure in *Vanessidæ* and *Papilionidæ*.

Aporia cratægi (fig. 10).

In *Aporia cratægi* the two rows of light spots have disappeared and the interveinal pigment has concentrated itself to as many rows of large black patches. Those of the outer row show the usual triangular form with rounded bases. In the first anal cell the two spots of both series clearly show their double nature, the original eighth and ninth spots having only partly coalesced.

At the beginning and the end of the rows, longitudinal black bands are found, marking the borders of the wing, and manifestly owing their origin to the coalescence of the first and last spots of the inner row with the corresponding ones of the outer.

The outer corner of the discoïdal cell is always marked by a big black patch.

When a sufficient number of specimens are examined, a considerable variability in the size of the blotches and the degree of their coalescence is seen to exist—a fluctuation which likewise occurs in *Pieris brassicæ*, and, in a somewhat different manner, in *Papilio machaon*. The black network of the veins is not strongly marked in *A. cratægi*, the inferior border-vein of the discoïdal cell being once more the broadest.

Euchloë cardamines (fig. 11).

The wing-sheath of *Euchloë* (*Anthocharis*) *cardamines* seems at first sight built after a wholly different plan, but on second consideration the same features are easily recognised. All the veins are marked in one and the same way by lighter bands in high relief, somewhat resembling the structure of the longitudinal veins in *P. podalirius*, but without the network of side-branches which is typical for this latter species.

But in *cardamines* these bands are much broader, and present a double character, their middle line being traced by a sharp groove. The interveinal spaces also resemble each other in presenting one and the same aspect—that of a dark ground-colour divided by a light middle stripe.

The latter stands out in high relief as a series of irregular

knobs, in the same fashion as the vein-traces, without, however, showing the longitudinal division. On close inspection a transverse series of light knobs may be distinguished in the same situation as the outer of the two rows of *Gonopteryx rhamni*, to which *E. cardamines* stands nearest, both in pupal form and in ornamentation of the wing-sheath. Accordingly, in this species also, a black patch, standing out in high relief, brings into prominence the corner of the discoïdal cell.

From the comparison of the pupæ of the representatives of these different families, *Nymphalidæ*, *Papilionidæ*, and *Picridæ*, I consider myself justified in drawing the following general conclusion: the wing-sheaths of these butterflies show a common ground-plan of ornamentation, consisting of dark pigment, accumulated partly along the pupal wing-veins and partly in the middle stripe of the wing-cell. Besides this distribution of coloured matter, two transverse series of interveinal knobs or spots of a lighter hue are found: one row along the outer margin of the imaginal wing-field, the other half-way between this margin and the transverse discoïdal vein. These knobs or spots are found in different stages of retrogression up to total disappearance.

THE DEVELOPMENT OF THE PRIMITIVE PATTERN.

1. *Vanessa urticæ*.

The development of the primitive or interpupal pattern begins very early, in the first days after pupation. At that period the wing-rudiments are in an embryonic or undifferentiated condition, the mother-cells of the scales still possess the character of simple epidermic cells, and the tracheal veins show the original arrangement (first discovered by FRITZ MÜLLER), without discoïdal cell-vein. The future colouring material is found in the mother-cells of the scales in the form of uncoloured pigment-grains, which on exposure to atmospheric air assume a red tint in the course of a few hours. Fixation in alcohol prevents this discoloration. Under normal conditions the wings are at the beginning fairly transparent, the pigment-grains do not as yet show a tint, and the light passes freely through them. But soon a difference between the antero-exterior and the postero-

interior part of the forewing becomes visible, the line of separation corresponding to the diagonal bar on the wing-case of the pupa. This difference is caused by the amount of opaque matter in the epidermic cells: the lighter-coloured field containing more of it, as can be proved by observing the wing in transmitted light, when we see the contrast between the two wing-areas changing into the opposite effect, the lighter part becoming darker, and vice versa (figs. 12 and 13).

Very soon after the first appearance of pigment-substance in the cells, the often-mentioned series of light spots parallel to the outer border of the forewing becomes visible. The spots do not arise all at one time, Nos. 4 and 5 being the first to become visible. They owe their distinctness to the same phenomenon which caused the contrast between the anterior and posterior wing-fields: accumulation of non-transparent pigment-matter in the cells of the epidermis. This matter reflects light more strongly than the surrounding wing-part, thereby calling forth the impression of a light spot in a darker field.

At the inner side of the anterior spots a darker area, of a more or a less triangular shape, can be observed: here the transparency of the wing has increased instead of being diminished.

The hindwings remain far behind the forewings in the development of a pattern, and do not pass through a stage of diagonal division into a lighter and a darker field. Their transparency lasts longer than that of the forewings, and passes very gradually into a general coloration of a cinnamon-brown tint. In their marginal interveinal spaces a series of light spots becomes visible, some days after those of the forewings, but of the same nature as these.

This primitive pattern remains in existence during almost the whole period of the chrysalid stage, without undergoing important modification, and then changes rapidly into the imaginal pattern. The modifications shown before the final alteration consist chiefly of a gradual diminution and final disappearance of the contrast between the two wing-fields, hand-in-hand with the development of a well-pronounced brown ground-colour over the whole surface of the wing. This ground-colour, however, only fills in the areas of the interveinal spaces:

the ribs themselves coming out as broad, light bands against this darker background. The whole arrangement shows a striking similarity to the wing-sheath pattern of *E. cardamines*, the only difference being the absence in the latter of the series of light intra-marginal spots.

According to my opinion, the primitive nature of this inter-pupal wing-colour pattern is proved by the following characteristics :

1. It is the same on upper and underside, and on fore- and hindwings.
2. It follows strictly the arrangement of the wing-nervures.
3. It is very simple in its constitution.
4. It contains those elements of the definite pattern which are common to the different members of the *Vanessa* family.
5. It shows a great and fundamental agreement with the pattern of the pupal forewing sheath.

The sudden change into the final or imaginal pattern must be regarded as a phenomenon of extreme abbreviation of this part of the phylogenetic development, perfectly comparable to the unforeshadowed change of the full-grown caterpillar into the imago-like chrysalis. In the ancestry of our *Rhopalocera* a period must have existed when butterfly-like insects possessed semitransparent wings, showing a colour-pattern similar to that of the pupal wing-sheath of to-day or to that of the primitive intra-pupal wing. Whether these ancestral wings were already covered with scales, or at least with hairs, or only with a more or less sculptured cuticula, and whether the colouring matter had already penetrated into the chitinous structures or was still lingering in the hypodermic cells, must be left undecided.

2. Other *Vanessidæ* (fig. 1).

Besides *V. urticæ*, I investigated the wing development in the pupæ of *V. io* and *Pyrameis cardui*, and found that in these three *Vanessidæ* an identical primitive pattern arises in one and the same manner, especially with regard to the series of light intra-marginal spots. The division of the forewing in a lighter and a darker area, however, is much less marked in *V. io*, and hardly if at all visible in *P. cardui*.

3. *Pieridæ* and *Papilionidæ*.

Coming to the development of the wings in the pupæ of *Pieridæ* and *Papilionidæ*, I am sorry to say that I find no difficulty in being short in my description. My hope and expectation that I should be able to discover a primitive pattern, just as clear and as interesting as in the case of the *Vanessidæ*, have up to this moment been disappointed. Nevertheless I feel absolutely confident in asserting that in these families the development of the wing-colours and pattern takes just the same course, and shows similar phenomena as in the *Nymphalidæ*. Without any doubt a primitive pattern arises also here at a very early period, on both sides of both wings, and remains in existence till a few days before the emergence of the imago, when the definite pattern enters upon the scene with the speed of a chemical reaction. And here again the different colours do not arise all at one time; on the contrary, in this case also the black makes its appearance some time after the other colours.

Neither in *Papilionidæ* nor in *Pieridæ*, however, does this primitive wing-coloration show such a well-defined design as in *Vanessidæ*, the intra-marginal series of light spots being absent on both fore- and hindwings. This fact corresponds with the character of the ornamentation of the pupal wing-sheath, in which the homologues of the said spots are likewise lacking, or at least are only very doubtfully marked (*Papilio machaon*, *Gonepteryx rhamni*).

In consequence of this deficiency the primitive pattern is forcibly restricted to the ground-colour, but the presence of this latter, in such a well-pronounced, characteristic way, is none the less a remarkable feature.

In *Pieris brassicæ* this primitive ground-colour is whitish, but its optical aspect differs from the white of the imaginal pattern.

In the few stages of *E. cardamines* I succeeded in observing, the wings, which had remained semi-transparent through the whole period of hibernation, got white and opaque at the beginning of spring, and then changed to a pink hue, which first invaded the interveinal spaces, but shortly afterwards coloured also the nervures, so that the whole wing became

uniformly rosy-red. This red bore the greatest resemblance to the same colour which was called forth by abnormal discoloration of the isolated pupal wings of *Vanessidæ* (and, as I can now add, of *Papilio podalirius*), but in *E. cardamines* it arose, without doubt, as a normal product.

In *Pieris brassicæ* I could not detect a single trace of red, either before or after the extirpation of the wing-rudiments from the pupal sheath, nor was I able to observe a similar phenomenon in the few pupæ of *Gonepteryx rhamni*, *Pieris napi*, and *Papilio machaon* that I had at my disposal.

In *Papilio podalirius* the ground-colour of the wings is a light cinnamon-brown, exactly resembling that of *Pyrameis cardui*. Especially the hindwings of these two species, belonging to different families, show the greatest resemblance during a considerable part of the pupal stage, as the marginal light spots proper to the *Vanessidæ* arise earlier on the fore- than on the hindwings. Therefore we may assert, with regard to the primitive coloration of the forewings of the *Papilionidæ*, that these wings remain unchanged in a condition which is rapidly passed over in the *Vanessidæ*.

On account of the absence of any spots or other markings on the growing wings of *P. podalirius*, the contrast with the complicated imaginal pattern is all the more striking, and the same remark applies as well to *Euchloë cardamines* and *Pieris brassicæ*. Nevertheless I feel confident in asserting that not only a primitive colouring, but also a primitive pattern, exists in *Papilionidæ* and *Picridæ* just as much as in *Nymphalidæ*. This pattern, however, is limited to a certain contrast in coloration and texture between the course of the nervures and the wing-spaces between them. The latter are darker than the former, owing to the accumulation of brown pigment-grains. Towards the middle lines of the internervural wing-spaces the brown colour gradually lightens, and so the effect is reached of wedge-shaped areas, beginning at the distal margin and reaching to the neighbourhood of the outer border of the discoidal cell.

These marginal wedges are not by any means so sharply circumscribed and well contrasted to the surrounding ground-coloration as the light spots in *Nymphalidæ*. They even partly owe their distinctness to the fact that the numerous

side-veins, springing perpendicularly from both sides of the main tracheæ, only penetrate for a short distance into the internervural spaces, and end there with a knob formed by a coiled part of the air-tube, the middle part of the space thus remaining free from tracheæ, and thereby reflecting the light in a somewhat different way.

Nevertheless I have satisfied myself, by careful inspection of fresh preparations, that, especially in *P. podalirius*, a real difference of colour-shades is perceptible, corresponding with the pattern of the pupal wing-sheath.

In *Pieris brassicæ* the difference between the central part and the margins of the internervural wing-spaces likewise becomes manifest, but only to a very slight degree, and during a short period preceding the universal whitening of the whole wing.

The above-mentioned observations on the development of a primitive colour-pattern seem to me to offer a weighty argument in favour of the hypothesis which I founded on the ornamentation of the pupal wing-cases and tried to strengthen by a comparison of the different imaginal patterns. The hypothesis in question was formulated by me in my article of 1911, "Ueber die Phylogenie der Flügelzeichnung bei Tagsschmetterlingen," in this wise: that the primitive wing-pattern of all Rhopalocera was brought about by a difference in coloration between the nervures and the median stripes of the internervural spaces, and that all the complicated imaginal patterns, with their almost infinite diversity of colours and markings, might be derived from this fundamental distribution of coloured matter over the wing surface.

IMAGINAL FORMS.

The examination of the pupal wing-sheaths, and the investigation of the young imaginal wings developing within, have led us to one and the same conclusion, viz. the occurrence during metamorphosis of a primitive wing-pattern, common to different families of Rhopalocera, and contributing more or less to the elements of the definite or imaginal pattern.

This primitive pattern we may, in a general way, describe as consisting of pigment-accumulation along the nervures and in the spaces of the wing-area between them, the former as well

as the latter originally showing a continuous distribution of coloured matter over the whole extension of the structural elements they belong to, but secondarily being frequently broken up into isolated patches of darker-coloured matter scattered over a lighter field. The internervural dark patches are by preference located both along the outer margin of the wing and near the line of origin of the marginal nervures from the discoïdal vein. Besides these patches of dark pigment one or two transverse rows of light spots may occur on the wings.

A third method of comparative morphology may also be followed: the investigation of the full-grown forms, with all their modifications by sexes, varieties, geographical races, aberrations, sexual and seasonal polymorphism, and, lastly, the examination of artificially produced deviations from the normal type. It is obvious that I must restrict myself to a few remarks on some of these topics, each of which contains full material for an extensive communication.

First of all I should wish to direct your attention to the fact that instances of wing-patterns more or less harmonising with the above-sketched primordial plan occur in all families of diurnal butterflies, and that among their bearers many forms are found which for different reasons may be considered as primitive.

One of the finest examples is *Hestia* (figs. 14 and 14a), among the Danaïds. In this genus almost all the features which may be regarded as characteristic of phylogenetically ancient forms show themselves in a striking way: simplicity of pattern and colours; restriction of the pigment-accumulations to the nervures and their intervals; concentration of the dark pigment into regularly arranged series of spots; accentuation of obliterated nervures by pigment-stripes, equality of fore- and hindwings and of upper- and underside.

These same conditions are almost as fully realised in the wing-pattern of the very interesting *Papilio zalmoxis* (fig. 15), which for various other reasons is regarded by competent entomologists as a relict from former periods of butterfly-existence, and likewise, though to a much less extent, in another aberrant member of that family: *Papilio* or *Druryia antimachus*.

From *zalmoxis* our attention is logically directed to Orni-

thopterae (fig. 16), and these offer a good opportunity for drawing attention to the great frequency, throughout the whole family of *Papilionidæ*, of the forewing bearing the unmodified primitive pattern, while the hindwing shows it in a much more differentiated and therefore less typical form. This observation agrees with the general fact that the hindwing shows more traces of having undergone modifications in the course of phylogenetic development than the forewing. In primitive Lepidoptera, such as *Hepialus*, fore- and hindwing are more alike than in genera standing higher in the phylogenetic scale, and this similarity is caused by the hindwing still showing the same structure as the forewing, not by the forewing having acquired the structure of the hindwing.

A second remark refers to the comparison of male with female Ornithopterae, when it is seen that the latter often show a complication and disturbance of the primitive pattern by the breaking up of the colour in the different internervural areas into alternately dark and light patches, and the confluence of the colour-figures of adjacent wing-spaces. In this, however, the female must be considered as the more modified sex of the two.¹

This same conclusion is independently reached by a study of those *Papilionidæ* which possess polymorphic females. The male form of *P. memnon* wears a simple uniform of primitive design; its different females all show various modifications of this pattern, chiefly depending on changes in the hindwings, but also more or less embracing the forewings. As the polymorphism most probably has arisen by secondary modification of an originally monomorphic ancestral type, it seems only logical to assume that the male did preserve this type, while in the females it became modified in various degrees and directions.

P. ucalegon furnishes us with an example of a mimetic form, and, besides, shows a general resemblance in wing-pattern to *P. zenobia*. Without in the least desiring to discuss the merits

¹ The figure given in illustration of this remark was taken from a figure in SEITZ'S Atlas, which bears the name "*æacus* ♀." So in this case the female does not show a pattern of her own, but one of the kind which in other species of Ornithoptera is characteristic for the male, that is to say, according to my opinion, the original or primitive one.

of the mimicry-hypothesis, I should wish to remark that, while inspecting the series of butterflies in search for specimens showing the primitive colour-pattern, I was greatly impressed by the considerable percentage of mimetic forms among my harvest. So the idea occurred to me that perhaps mimetism might, at least to a certain degree and for a limited number of cases, be explained by supposing the resemblance between two or more non-related forms to have started at an early period, when the ancestral types of different butterfly-families looked more like each other than nowadays, on account of the primitive colour-pattern common to them all.

My remarks on the wing-sheath of *P. machaon* and *podalirius*, and on the pattern of their growing wings, have made it already clear that I cannot in the least agree with EIMER's hypothesis about the high significance and the phylogenetic primitive nature of the transverse¹ dark bands which are found in different numbers and extension on the wings of many forms of *Papilionidæ*, especially on those of the *podalirius* group of species. The figures in EIMER's book show a primitive development of the said bands as regards their number (*i.e.* eleven), extension, and arrangement, according to EIMER's view. If we analyse these figures from our point of view, assuming that transverse bands have arisen by the coalescence of neighbouring spots in adjacent internervural wing-spaces, we can arrange the different forms belonging to the *podalirius* and *machaon* groups into a phylogenetic series, just as well as EIMER himself, only we have to start from a different point of origin. Forms like *P. xuthus* (fig. 18), which shows remnants of the primitive longitudinal pattern in the discoïdal cell of the forewing, convince us that the transverse bands in this cell have arisen by secondary modification of these nervural traces, and thereby render it probable that similar bands in other parts of the wing may have originated in the same way.

As to the red flames occurring in different numbers, mostly on the underside of the hindwing of various members of the group (fig. 19), they represent, in my opinion, traces of a primitive internervural pattern, in the same way as do the white spots on the forewing of the *Vanessidæ*. It is interesting to remark

¹ EIMER calls them longitudinal bands.

that EIMER was obviously impressed by the phylogenetic importance of these flames, and studied their occurrence and distribution. In our opinion a form such as *P. hellanicus* (EIMER, ii., Taf. vii., fig. 5), where the flames occur in nearly all the spaces and on both sides of fore- and hindwing, has best preserved the original colour-arrangement, and *P. asterias* var. *Calverleyi* is a variety due to reversion to the common ancestral form (fig. 20). This aspect of the question furnishes us with an explanation of the fact that this same deviation from the general type occurs as a rare aberration in *P. machaon* (as described by SPENGLER from the specimen in the Tring Museum).

Now, coming to the *Pieridæ*, it may be said that in a few members of this family the concentration of pigment along the course of the nervures and along the middle lines of the marginal interspaces occur in quite the same fashion as among the *Papilionidæ*. *Dismorphia mimetica* (fig. 21) is an instance of this primitive arrangement, and again of its presence in a mimetic form.

From all the genera belonging to this family examples may be easily picked out which show the original internervural pigment concentrated into a transverse row of spots: DIXEY'S "submarginal series of dark spots." I should wish to remark that according to my view these spots need not necessarily be always dark, nor necessarily have a rounded outline: they may also be light, or at least white-centred, and thereby lengthened to the form of stripes, or may be v-shaped, or united with their neighbours to irregular transverse bands, or otherwise developed.

These spots are found more frequently on the under- than on the upperside, and are better preserved in the more primitive representatives of the family (f.i. *Archonias*) than in the more highly differentiated forms; also oftener in the females than in the males, the former being here the least modified. A figure of *Callidryas scylla* ♀ (fig. 22), in PIEPERS'S new standard work on the Rhopalocera of Java, shows nearly the whole series as well on upper- as on underside.

Very often these spots stand at or near the proximal end of a coloured line marking the axis of each internervural space, and therefore probably represent the primitive pattern, which also is visible for a moment during the pupal life.

Summing up the conclusions to which my researches have led me, I should wish to mention not only those relating to the topics just laid before you, but also some general laws, which, according to my view, may be relied on in phylogenetic speculations.

1. During metamorphosis, the colour-pattern on the butterfly-wings passes through a series of stages, representing a phylogenetic sequence, and therefore may be of use in judging of the ancestral affinities of allied species.

2. One of these stages is found depicted on the wing-sheath of the chrysalis ; another one, very similar to the first, but probably still more primitive instead of more advanced, makes its appearance during pupal life on the wings of the future imago.

3. The components of this primitive pattern are strictly confined to the internervural spaces, and show a great equality among each other, thereby producing a similarity in design between fore- and hindwings, upper- and underside.

4. Some of the elements of this primitive pattern pass directly into the definite one, forming some of those features of the latter which are common to the species of one genus, to the genera of one family, and probably even to families of one order.

5. These ontogenetic results give a fresh confirmation of the principles derived from the comparative investigation of imaginal forms ; telling us that similarity of fore- and hindwing, of upper- and underside, and repetition of the same elements of design in succeeding internervural spaces, may be considered as being more primitive than the contrary, or at least as an atavistic return to the ancestral condition.

6. The special hues or shades of the colours of the pattern are not of primary importance, but may be regarded as secondary modifications in the constitution of one or a few fundamental colouring substances, if they are not merely caused by the physical structure of the scales. By these modifications the primary pattern may be more or less disturbed, obscured, and even rendered invisible. Monochromatism (self-colour), *f.i.*, is always to be regarded as a final specialisation ; the simplicity of such a unicolorous form has nothing to do with primitiveness.

7. In the development of the (differentiated) imaginal pattern

from the original or ancestral one, the upper surface of the wing has often further deviated than the opposite one, and the hindwing has become more specialised than the forewing. Especially in many *Papilionidæ* the forewings have often preserved the primordial pattern in a remarkably unchanged state.

8. When a difference in wing-design exists between male and female, the latter has often, but by no means always, preserved more of the primordial pattern than the former. *E.g.* unicolorous males of *Pieridæ* (gen. *Tachyris*) are more modified than their spotted females, while, on the contrary, the males of some polygynomorphic *Papilionidæ* wear a uniform of more ancestral pattern than all or some of their spouses.

EXPLANATION OF PLATES XXXII, XXXIII, XXXIV.

- PL. XXXII. Fig. 1.—*Pyrameis cardui*. Imaginal forewing extracted from the pupa, showing the primitive pattern.
 Fig. 2.—Wing-sheath of the pupa of *Vanessa urticæ*, photographed from a preparation in Canada-balsam (touched up).
 Fig. 3.—The same not touched up (the edge unfortunately cut off by the maker of the block).
 Fig. 4.—Pupa of *Vanessa io*.
 Fig. 5.—Pupa of *Papilio machaon*.
 Fig. 6.—Pupa of *Papilio podalirius*.
 Fig. 7.—Pupa of *Thais polyxena* in three aspects.
- PL. XXXIII. Fig. 8.—Pupa of *Pieris brassicæ* (the tip of the frontal process painted out by the maker of the block).
 Fig. 9.—Pupa of *Gonepteryx rhamni* (the vertical line on the thorax is due to a flaw in the block).
 Fig. 10.—Pupa of *Aporia cratægi*.
 Fig. 11.—Pupa of *Euchloë cardamines* (see note to fig. 8).
 Fig. 12.—Developing wings of *Vanessa urticæ* extracted from the pupa; seen in reflected light.
 Fig. 13.—The forewing of the same seen in transmitted light.
- PL. XXXIV. Fig. 14.—(a) *Hestia imperialis* from upperside; (b) *Hestia idea* from underside (from set specimens).
 Fig. 15.—*Papilio zalmoxis*, taken from the figure in STAUDINGER and SCHATZ.
 Fig. 16.—*Ornithoptera æcius* ♀ (taken from SEITZ's Atlas).
 Fig. 17.—*Papilio ucalegon* (from STAUDINGER and SCHATZ).

- PL. XXXIV. Fig. 18.—*Papilio xuthus*, underside (from EIMER's *Orthogenesis*).
- Fig. 19.—*Papilio hospiton*, underside (from EIMER's *Orthogenesis*).
- Fig. 20.—*P. asterias* ab. *Calverleyi* ♀, underside (from EIMER's *Orthogenesis*).
- Fig. 21.—*Dismorphia mimetica* (from STAUDINGER and SCHATZ).
- Fig. 22.—*Callidryas scylla* ♀ (from PIEPERS'S *Rhopalocera of Java*).

NOTES ON THE APHIDES OF THE CULTIVATED PEAS
(*PISUM SATIVUM* AND *LATHYRUS LATIFOLIUS*)
AND THE ALLIED SPECIES OF *MACROSIPHUM*.

By FRED. V. THEOBALD, M.A., F.E.S., Hon. F.R.H.S., etc.

(Plates XIV and XV.)

IN certain years the pea crop, both field and garden, suffers to a considerable extent from the attack of *Aphis*. This is not only the case in Europe but also in America. In Britain I have found three species feeding and breeding on peas, not only on the edible varieties but also on sweet peas, everlasting peas, and the Blue Pea.

By far the most general and serious enemy is the Green Pea Louse (*Macrosiphum pisi* Kaltenbach).

The other two are *Megoura viciae* Kaltenbach and *Aphis rumicis* Linnæus. The latter has perhaps the widest range of food plants of all the Aphididæ, but it seldom does much damage to peas, and as I have treated it elsewhere nothing will be said concerning it here.¹

The Green Pea Aphis (*M. pisi* Kalt.) has several close allies feeding on different plants, two of which were described as distinct species, but which since have been sunk as synonyms. I wish to show here that they are quite distinct species. This narrows down the great difficulties of preventive treatment, as if the Green Pea Louse bred on several very abundant wild plants, which grow in almost every wood and hedgerow, the possibility of checking this pest would be well-nigh insurmountable.

KALTENBACH, in describing *Aphis pisi* (*Mono. Pflanz.*, 23, 11), refers to *Aphis ulmarie* Schrank (*Faun. Boic.*, ii., 111, 1221).

SCHRANK'S name *ulmarie* has been adopted by WALKER, BUCKTON, SCHOUTEDEN, and others for the green *Macrosiphum* on the Pea, Meadow Sweet, Wild Avens or Geum, and other plants.

¹ *Journal Board of Agriculture*, vol. xix., No. 6, September 1912, pp. 466-76.

The synonymy given by WALKER (*Cat. Homop. B. M.*, 4, p. 966) is as follows:

Aphis ulmariae Schrank, *Faun. Boic.*, ii., 111, 1221.

Aphis onobrychis Fonscolombe, *Ann. Soc. Ent. Fr.*, x., 169, 9.

Aphis lathyri Mosley, *Gard. Chron.*, i., 684.

Aphis pisi Kaltenbach, *Mono. Pflanz.*, i., 23, 11.

Aphis pisum Harris, *Exposit. Engl. Ins.*, 66, Pl. 7, figs. 10-12.

And in the Supplement to the same work, p. 291:

Siphonophora gei Koch, *Pflanzenl.*, 171, 176, Pl. 321, figs. 234, 235.

Aphis ulmariae, *p. Cat. Hom.*, 966.

SCHOOTEDEN (*Cat. d. Aphid. Belg.*, *Mém. Soc. Ent. Belg.*, t. xii., p. 240) gives the following synonymy:

Macrosiphum ulmariae Schrank.

destructor Johnson.

gei Koch.

lathyri Walker.

onobrychis Fonscolombe.

psi Kaltenbach.

BUCKTON (*Mono. Brit. Aphid.*, i., p. 133) retains KALTENBACH'S name, giving the following synonymy:

Siphonophora pisi Kaltenbach.

Aphis ulmariae Schrank.

Aphis onobrychis Fonscolombe.

Aphis pisi Kaltenbach.

Aphis lathyri Walker, Mosley.

Siphonophora pisi Koch.

Siphonophora ulmariae Passerini.

FERRARI (*Aphid. Liguriae*, p. 54) gives the following synonymy:

Siphonophora ulmariae Schrank.

A. onobrychis Fonscolombe.

A. pisi Kaltenbach.

S. gei Koch.

KALTENBACH (*Mono. Pflanz.*, p. 23) in describing *Aphis pisi* says it lives in July on *Pisum sativum* and *P. arvense*, on *Lotus uliginosus*, *Ononis repens*, and *O. hircina*, on *Trifolium pratense* and *T. filiforme*, on *Lathyrus odoratus*, *Spartium scoparium*, *Colutca arborea*, *Geum urbanum*, *Spiraea ulmaria*, *Ephilobium montanum*, *Chærophyllum temulum*, *C. sylvestris*, etc.

Evidently from this list KALTENBACH had confused several species, owing to their similarity in colour and form.

SCHOUTEDEN (*Cat. Aphid. Belg.*, p. 240) gives as food plants for *M. ulmariae* Schrank the following: *Colutea arborescens*, *Genista tinctoria*, *Robinia pseudacacia*, *Trifolium* var. sp., *Spiraea ulmaria*, etc.

FERRARI (*Aphid. Liguria*, p. 54) gives as food plants "*Geo urbano*, *Rosis cultis*, et *Hyosieride radiata*."

BUCKTON (*Mono. Brit. Aphid.*, i., p. 135), besides saying it affects a large number of plants besides the pea, also says "The glaucous female in Pl. XIV was taken on the common nettle *Urtica dioica*."

The specimen figured is evidently not KALTENBACH's *pisi* at all. DAVIDSON (*Journ. Eco. Ent.*, iii., p. 380) also mentions it as occurring on *Urtica holoserica*.

From a careful examination of the Green Aphides of the Genus *Macrosiphum* (formerly called *Siphonophora*) found on the Meadow Sweet (*Spiraea ulmaria*), the Avens (*Geum urbanum*), the Peas (*Pisum* spp.), Bird's Foot Trefoil (*Lotus corniculatus*), and Stitchwort (*Stellaria graminea*), I find they are all distinct and well-marked species. The Green Aphis on the Rest Harrow (*Ononis arvensis*), the *Siphonophora ononis* Koch, is also evidently quite distinct, judging from a single alate specimen I have.

All these Aphides bear a very strong resemblance to one another, so much so that one can quite imagine KALTENBACH and others grouping them together.

When, however, one examines the structure and ornamentation of the antennæ and cornicles, marked differences can be seen between certain of them.

In the alate females these characters are most marked; the number and disposition of the sensoria of the antennæ and the sculpturing of the cornicles are easily demonstrated in specimens mounted in Canada balsam, and this also applies to the apterous females, but not quite to the same extent. In the nymphæ these characters are frequently absent, however.

We can divide this group of *Macrosiphum* primarily into two:

A, the *pisi* group, in which the cornicles are entirely imbricated, and sensoria occur on the third antennal segment. These

I have only found on Papilionaceæ. In this group come *pisi* Kaltenbach, *ononis* Koch, and apparently two new species which I propose to call *loti* and *trifolii*.

B, the *ulmarie* group, in which the cornicles are reticulated at their apices and again have sensoria on the third antennal segment only. In this group come *ulmarie* Schrank, *gei* Koch, and *stellarie* nov. sp.

GROUP A.

Species I. *Macrosiphum pisi* Kaltenbach (Pl. XIV, fig. 1, fig. 2 C).

Aphis pisi Kaltenbach.

Siphonophora pisi Koch.

Nectarophora destructor Johnson.

Aphis onobrychis Fonscolombe.

Aphis pisum Harris.

Aphis destructor Patch.

Aphis lathyri, Walker, Mosley.

Nectarophora pisi Sanderson.

This is the common Green Pea Louse found all over Europe and America, and I have had specimens sent me from Natal. The general colour of the insect is green, varying from pale apple green to grass green in all stages. I have never found pink forms.

Wingless Viviparous Female.—Green, roughly spindle-shaped and elongated, smooth and somewhat shiny; eyes red; abdomen showing sometimes six darker spots on each side.

Legs green to yellowish green with dusky apices to femora and tibiæ and dark tarsi. Tail ensiform, long; antennæ very long, pale yellowish green, the apices of the segments dark, sixth segment mostly dark; the fourth about three-fourths the length of the third, fifth not quite as long as the fourth and fifth together; the third has two or three sensoria at the base. Cornicles pale green, dusky at the apex, long and thin, but not reaching beyond the long tail, imbricated along the whole length. *Length*, 2·2–2·9 mm.

Winged Viviparous Female.—Green of various shades, some very pallid, others apple green or grass green, with sometimes

a mealy coat, others shiny. Eyes red to black. Antennæ very long, similar to the apterous female, but usually somewhat darker, colours varying from pallid yellow to green or olive green. Cauda long and ensiform, but not so long as in the apterous female in some specimens. Cornicles long and thin, often reaching as far as the cauda, pale green to yellow green, dusky just at the tip, imbricated for their whole length.

Fourth antennal segment not quite as long as the third, the third with a line of 12 to 16 sensoria not reaching the apex, fifth about as long as the fourth, no sensoria on the fourth or fifth; sixth as long as the fourth and fifth or slightly longer, all the segments faintly striate.

Wings with yellowish stigma, varying to yellowish green.

In some specimens the thoracic lobes are slightly darkened.

Length, 2.5 to 3.3 mm.; wings 9.0 to 9.4 mm.

The Pupa.—This stage is much like the apterous female, but the wing-cases are dusky at the apices, and there is now and then somewhat darker mottling and a darker green dorsal line. Like the former, the skin may carry a mealy covering. The third antennal segment shows no sensoria, and the cauda is shorter and broader.

This species occurs on peas from May until August, but the majority do not occur on the peas until they are well in blossom.

Species 2. *Macrosiphum loti* nov. sp. (Pl. XIV, fig. 2 A).

Apterous Viviparous Female.—Similar in colour to *pisi*, but the cornicles are relatively much longer and thinner, the cauda shorter, and the third segment of the antennæ has a single reniform sensorium near the base.

Found only on *Lotus corniculatus* in July and August at Wye. They are found on the leaves, and also cluster in dense masses on the green seed-pods. They fall readily when on the pods, but hold more tenaciously to the leaves. I have never been able so far to breed the alate form, but nymphæ have been obtained.¹ The single sensorium at once separates it from true *pisi*. Specimens transferred to late garden peas did not live on them.

Species 3. *Macrosiphum trifolii* nov. sp. (Pl. XIV, fig. 2 B).

¹ Since this went to press the alate female has been found, and is being described in the *Journal of Economic Biology*.

Apterous Viviparous Female.—Very similar in colour to the two former, but usually a paler green, the antennæ relatively thicker, the fourth segment nearly as long as the third, the fifth as long as the fourth, no sensorium on the third.

Found on *Trifolium procumbens* the first week in August, breeding in small numbers amongst the flower-heads at Wye and Hastings. I also transferred these to peas, but the colonies soon died out.

GROUP B.

Species 4. *Macrosiphum ulmariae* Schrank (Pl. XIV, figs. 3 and 6).

Winged Viviparous Female.—Various shades of green with mealy coat in most cases. The head, antennæ, legs, and cornicles slightly darker than in *pisi*. The green legs have a larger dark area at the apices of the femora and tibiæ, and the tarsi dark. The ensiform cauda is pale yellowish green, and the cornicles are relatively thicker than in *pisi*; moreover, their dusky apices are markedly reticulate, and there are some apparent transverse lines below, but no imbrication.

The third antennal segment has a line of sensoria varying from 14 to 19 on one side; remaining segments without any sensoria.

Length, 2 to 3 mm.; wings 9·2 to 9·8 mm.

Apterous Viviparous Female.—Green of various pale shades, often with a mealy coat. Antennæ about as long as the body, apices of third, fourth, and fifth, and all the sixth segment dusky, fourth slightly shorter than the third, fifth about equal to the fourth, no sensoria on the third. Cornicles green, dusky at the apex, showing faint reticulation. Cauda pale yellowish green, shorter and blunter than in the alate female. Legs all yellowish green, except the tarsi.

Length, 2·5 to 3 mm.

Nymph.—Like the above, the wing-tips being slightly dusky.

A pink variety occurs side by side with the green and produces exactly the same winged females. The only difference is that in the pink forms the apices of the tibiæ are dusky.

This species I have found in many places in Kent, Sussex,

Surrey, Hampshire, and Huntingdonshire, and I have taken it in Devonshire, Cornwall, Worcester, Hertfordshire, and Shropshire.

It lives in dense clusters up the flower-stalks of the Meadow Sweet (*Spiræa ulmaria*), usually one closely fixed behind the other. They are very timid and fall to the ground at the least shock in all stages, whilst I have found that *M. pisi* sticks fairly tenaciously to the pea when young, but by no means always. I have found this *Aphis* from May to June as apterous females; nymphæ commence to appear from the first week in June and alate females from then on to July, when it disappears from the *Spiræa*. Frequent trials to plant this *Aphis* on cultivated peas at various times have always ended in failure.

Species 5. *Macrosiphum gei* Koch, *Siphonophora gei* Koch (Pl. XIV, figs. 4, 7 B).

Winged Viviparous Female.—Green and very similar to the former; the antennæ are darker and the legs may be a darker green than in the former, there being a dark area at the apex of the femora and tibiæ and dark tarsi, and the thoracic lobes may be darkened. The ensiform cauda is yellowish green; the cornicles are green with dusky apex, which is reticulate, and below are a few transverse lines. Third segment of antennæ with 14 to 16 sensoria in a line extending for rather more than half the length of the segment, none on the remainder.

Wingless Viviparous Female.—The cornicles the same as in the alate form. The third segment of the antennæ with three sensoria near the base. Cornicles dark at their apices.

Nymph.—Cornicles imbricated for their whole length, and darker than in the other two stages. Antennæ without sensoria on segment three. Wing-buds dark brown and cornicles dark.

Abundant in Kent, Surrey, Sussex, Hampshire, Hertfordshire, and Essex on the Wild Avens (*Geum urbanum*), forming dense clusters up the flower-stalks closely packed together. They fall readily, as does the previous species. This species occurs from the end of April through into June. Nymphæ appear at the end of May, winged females in June, and by the first week in July they have mostly left; all have gone by the second week. I have never been able to take them on the wing or find an alternative host plant.

Many attempts have been made to plant this Dolphin on

cultivated peas, but the colonies soon died off, the young produced by the alate females only living a few days.

Species 6. *Macrosiphum stellariæ* nov. sp. (Pl. XV, figs. 5, 7 C).

Wingless Viviparous Female.—Pale green to apple or grass green, very like *pisi*; but the antennæ not so long and the cornicles thicker.

The cornicles are green with dark apices, apices reticulate, remainder with a few transverse striæ.

The third segment of the antennæ has a group of five or six sensoria near the base, and the fifth and sixth segments are dusky.

Found in abundance at Ecclesbourne Glen and other places near Hastings, and once at Wye on the Stitchwort (*Stellaria graminea* Linn.). A few apterous females found at the end of April, and by May 15th these had produced a goodly progeny. The females sheltered between the leaves, and owing to their colour were difficult to detect. I failed to find more than one small colony at Wye, and these died off before any winged brood was produced. It is clearly distinct from the other green *Macrosiphæ* and is in no way connected with the Green Pea Louse (*M. pisi* Kalt.), owing to the reticulate cornicles, and differs from *gei* Koch and *ulmaricæ* Schrank in the arrangement of the sensoria on the third antennal segment.¹

NOTES AND OBSERVATIONS ON THE DISTRIBUTION, HABITS, FOOD PLANTS AND LIFE CYCLE OF *MACROSIPHUM PISI* KALTENBACH IN BRITAIN.

The Green Pea Louse or Dolphin I have definitely found on the following plants in Britain: all varieties of cultivated culinary and ornamental peas (*Pisum*), on the wild Everlasting Pea (*Lathyrus sylvestris*), on cultivated *Lathyri*, on Red Clover (*Trifolium pratense*), White Clover (*T. repens*), Alsike Clover (*T. hybridum*), and on the Shepherd's Purse (*Capsella bursa-pastoris*).

It usually appears on the garden and field peas in late May,

¹ Since this paper went to press I have found the alatæ at Bramley in Surrey and at Little Hadham in Hertfordshire.

June, and early July, and goes on until the end of August, and I have found a few as late as September 12th. The winged females leave the dying peas and fly to the wild Everlasting Pea (*Lathyrus sylvestris*) and the cultivated garden Everlastings and also to clover, where the sexuparae are later produced. The ova I found were laid low down on the haulm, close to the ground as a rule, but some on any part of the plants. At first they are green, but in a few days assume the black shiny colour so characteristic of Aphis eggs. In 1907 I found the ova hatching on March 27th, at which time the Everlasting Peas were first shooting above the soil. The same happened on clover, where the majority seem to winter and live until they migrate to the peas and set up the summer progeny. Normally their autumn, winter, and spring habitat in this country is clover and the wild *Lathyrus sylvestris*. The colonies I have found on the Shepherd's Purse (*Capsella bursa-pastoris*) in the autumn have never survived. PATCH (*Bulletin* No. 190, Maine Agricultural Experiment Station, U.S.A.) was unable to get this Aphis to live on *Trifolium pratense*, but was able in August to get them to breed on Shepherd's Purse, but no mention is made of the sexuparae. Various other plants were tried by Miss PATCH, such as barley, wheat, oats, purslane, beets, and squash, but the colonies all died out.

In 1910 I placed colonies on willow, raspberry, clematis, clover, and Lathyrus, and only on the two latter did they continue to breed until the autumn, when an ovigenuous race was produced.

This, then, narrows down the list of summer and winter host plants, and so by the destruction of the perennial wild peas, and the feeding off of clover prior to migration, much may be done to lessen the damage that in certain years is very serious.

GENUS MEGOURA Buckton.

Megoura viciae Kaltenbach, *Aphis viciae* Kaltenbach.

This insect was described by KALTENBACH (*Mono. Pflanz.*, p. 20, 1843) as feeding on *Vicia sativa*, *V. sepium*, *V. angustifolia*, and *V. faba*, also on *Lathyrus pratensis* from June to September.

I have found it in abundance on garden peas, the colonies

mixing with those of *Macrosiphum pisi* Kalt. in some cases and in others alone. It also now and then occurs with the Black Dolphin or Collier (*Aphis rumicis* Linn.) on broad beans in a similar way. In those districts where I have known it, near Great Staughton in Hunts and at Wye in Kent, and years ago at Kingston-on-Thames in Surrey, it was always common on *Lathyrus sylvestris*. Last year I removed a colony from the latter plant in June and placed them on peas and broad beans in my garden. They flourished to an alarming extent on both plants. Those on the beans became winged in July and left. Watch was kept on two large masses of *Lathyrus* in the neighbourhood, and I found that from June 30th to July 20th winged females appeared, and from then onwards I saw no trace of them on the peas. From that date onwards these insects flourished on *Lathyrus* as in the spring, and in November I found ova low down on the haulm. It is thus clear that this handsome Dolphin also migrates between the wild Everlasting Pea (*Lathyrus sylvestris*) and the cultivated peas and beans. I tried to cultivate the summer brood from peas on clovers, and on a white Everlasting Pea a variety of *Lathyrus latifolius*, but without success.

These two cases show what we may naturally expect—that the insects of this group found on the annual plants pass the winter on the perennials so as to ensure their continuity of existence.

Moreover the host plants do not seem to be very varied, and certainly do not pass out of the Papilionacæ, as we see is done by the third species sometimes found on the peas, the Black Fly, or *Aphis rumicis*, which has such a vast number of food plants, ranging from the dock and onion to the mangold, bean, poppy, and chamomile, and even apples.

BUCKTON (*Mono. Brit. Aphid.*, i., 188) placed this *Aphis* in a new genus, *Megoura*, which was certainly justified.

SCHOOTEDEN (*Cat. Aphid. Belg.*, p. 240) sinks this genus under *Amphorophora* Buckton, in which I cannot agree, as BUCKTON'S type of the latter genus—*Amphopophora ampullata* Buckton, is an insect of totally different facies.

BUCKTON says his *M. viciæ* is certainly neither KOCH'S *Siphonophora viciæ* nor KALTENBACH'S *Aphis viciæ*. I am fully

in agreement with SCHOUTEDEN that it is only KALTENBACH's species.

BUCKTON's specimens were obtained from Keteringham, some few miles distant from Norwich, where Mr. Barrett found them during two successive Septembers feeding on the green seed-pods of the Vetch, *Vicia sepium*. I have only found it at Wye and Faversham in Kent, and at Widdington in Essex, in any numbers, on cultivated peas.

The object of this paper is to show that *Macrosiphum pisi* of KALTENBACH is a distinct species, and to reinstate KOCH's *Siphonophora gei* at the same time, and above all to fix the identity of the European Green Pea Louse, which is not the *ulmarie* of SCHRANK, but the species described by KALTENBACH as *pisi*.

SOME PREVIOUS OBSERVATIONS OF THE PEA APHIDES.

CURTIS (*Farm Insects*, p. 493) refers to the Pea Aphis as *Aphis viciae* Fabricius and *A. pisi* Curtis.

He found a green Aphis in abundance in May and June on vetches, and in mid-June on grey peas; in the beginning of July winged females appeared, "and were no less plentiful on the bloom," says CURTIS.

CURTIS refers to the winged male as being black or brown; antennæ longer than the body; femora and tibiæ more or less yellow towards the base.

This is evidently not the male of *M. pisi* Kalt., and is probably *Aphis rumicis*.

ORMEROD (*Ninth Rept. Inj. Ins.*, p. 62, 1886) refers to a bad attack at Kingsnorth, Kent, the Dolphin appearing about the time the first flowers expanded. On July 24th the peas were cut, and it was noticed that the Aphides fell until the ground was covered with them, and they crawled up every available plant, giving a superficial resemblance to the green flower-head of some orchidaceous plant. The insects nearest the stem were noticed to be lice, closely packed, frequently two or three layers thick, and then outside these a coat of "fly," with their heads all pointing upwards. Next day all the fly and the greater part of the lice had disappeared. Tares were also attacked.

LAMPA mentions this *Aphis* as harmful in Sweden (*Uppsätser Praktisk Entomologi*, 17, p. 5, 1907).

It was recorded for the first time in America from Maine, along the Atlantic coast southwards to North Carolina and westwards to Wooster, Ohio, in 1899, and was also observed in Nova Scotia and Ottawa, Canada (Notes upon the destructive Green Pea Louse (*Nectarophora destructor*) for 1900, *Bull.* 26, N. Se. U. S. Dep. Agri. Div. Ent., p. 55, 1900). JOHNSON also recorded it from Massachusetts and Vermont in July and August, and also from Chillicothe, Ohio, Long Island, N.Y., portions of New Jersey, and Wisconsin, in August.

JOHNSON, who first observed this pest in May 1899, described it as *Nectarophora destructor* in the *Canadian Entomologist* (February number).

JOHNSON refers in this paper to the great damage done to both red and crimson clover, and he considers red clover its original food plant and thus thinks it primarily a clover pest.

In the south he found it spent the winter in the adult state in clover fields, but suggested that farther north it may pass it in another form.

NEWELL and ROSENFELD (*State Crop Pest Commission of Louisiana*, Circ. No. 27, p. 108, 1909) refer to its damage in Louisiana and to its wintering in the egg stage. They refer to it as *Nectarophora pisi* Kalt.

DAVIDSON records it from California on *Vicia* sp. (?), on cultivated beans, and on *Urlica holoserica* (*Journal Eco. Ent.*, iii., p. 380).

GILLETT took this *Aphis* on *Trifolium pratense* at Albany, N.Y., July 1st, and also received specimens from Maryland, and says it is very abundant in Colorado on both eastern and western slopes, where it was taken on the Garden Pea, *Lathyrus odoratus*, and Alfafa, *Mcilolus alba*. He identified them from specimens taken by COCKERELL from Sussex, England, on peas in July 1909. His figures of the antenna and cornicle of the winged female agree with our European *pisi*, but the cornicle of the apterous female (Pl. XVI, fig. 24) certainly does not, as there is no trace of apical reticulation in true *pisi* such as he figures. He also mentions the sensoria at the base of segment three as varying from 2 to 5. I have never seen more than

three in any European specimen (*Journ. Eco. Ent.*, iv., p. 304, Pl. XVI, figs. 22-24).

FLETCHER has referred to this pest in Canada, saying that in the summers of 1899 and 1890 it practically destroyed the whole of the crop of late peas from the Southern States and over the greater part of Canada, east of the prairies (*Insects Injurious to Grain and Fodder Crops, Root Crops, and Vegetables*, Bull. No. 52, p. 27, Dep. Agri. Ottawa, Canada).

FLETCHER gives a fuller account of this pest in Canada in his annual Report for 1899, pp. 170-74. In this reference is made to another kind of Aphis, attacking the roots of sweet peas, of a brick red colour.

He also refers to several kinds of predacious insects attacking the Green Pea Louse, including Lace-wing Flies, Lady-birds, *Syrphus* larvæ. Of Lady-birds the chief were *Hippodamia convergens* Guer, *Coccinella 9-notata* Herbst, the larvæ of *Syrphus ribesii* Linn.; also *Plaon cerasaphis* Fitch and *Aphidius fletcheri* Ashmead.

BIRDS FEEDING ON THE GREEN APHIS.

At Kingsnorth Mr. HART found that starlings came by hundreds to feed upon them, and to some extent willow wrens, white-throats, and the smaller tits (*Paridæ*). During a bad attack at Wye Court Farm in 1900 sparrows were noticed clearing off the "Green Dolphin" in company with hosts of starlings, also brown linnets, and had it not been for these birds the crop would have been more seriously damaged.

Treatment.—Two methods of treatment have been tried, namely (1) spraying, and (2) the brush and cultivator method.

Spraying can only satisfactorily be carried out in staked garden peas; dwarf varieties, like "William Hurst" and field peas, cannot be properly treated in this way. As a spray I have found soft soap and quassia at the usual strength quite sufficient to destroy them, but tobacco extract and soap certainly act more quickly.

The brush cultivator method used in America is scarcely likely to come into vogue in Britain, as it necessitates planting the rows of peas too far apart. One plan adopted in America is for two boys to walk along the spaces between the rows,

leaving one space between them; along this space follows a cultivator which destroys the Aphides. Even this has to be repeated at intervals if the lice continue to increase. These methods have been tried in England, and they are not found practicable owing to the different method of cultivation.

PL. XIV. Fig. 1.—*Macrosiphum pisi* Kalt., alate female.

A. Cornicle.

B. Cauda.

C. Antenna.

Fig. 2.—A. *Macrosiphum loti* nov. sp. apterous female.

B. *Macrosiphum trifolii* nov. sp.

C. *Macrosiphum pisi* Kalt.

Fig. 3.—*Macrosiphum ulmariae* Schrank, alate female.

A. Cornicle.

B. Antenna.

Fig. 4.—*Macrosiphum gei* Koch, alate viviparous female.

A. Cornicle.

B. Antenna.

PL. XV. Fig. 5.—*Macrosiphum stellariae* nov. sp.

Fig. 6.—*Macrosiphum ulmariae* Schrank, apterous female.

A. Cornicle.

B. Antenna.

Fig. 7.—B. *Macrosiphum gei* Koch.

C. *Macrosiphum stellariae* nov. sp.

A SYNOPSIS OF THE THYSANOPTEROUS FAMILY ÆOLOTHRIPIDÆ.

By RICHARD S. BAGNALL, F.L.S., Hope Dept. of Zoology,
University Museum, Oxford.

THE *Æolothripidæ* are a small but abundantly characterised family of the *Terebrantia*, of which only about two dozen species are described. The fact that the species of this family are moderately large, and would therefore not be overlooked, goes to show that though widespread in their distribution the family is not largely represented, otherwise more material would have come into the hands of Thysanopterists.

The group is an interesting one, as it is apparently composed of the most primitive Thysanopterous insects, which, considering recent discoveries made in the United States of America, would seem to have originated in the New World.

Unlike most families of the order, the genera and species of *Æolothripidæ* can be separated on very satisfactory and definite structural characters.

Sub-order **Terebrantia.**

Family *Æolothripidæ*.

Antennæ nine-segmented, either freely movable or with the apical joints connate; intermediate segments usually cylindrical, without specialised chætotaxy, but uniformly clothed with short setæ. No sense-cones present; membranous, longitudinally elongated sensory areas on segments three and four, and smaller areas on certain other segments. Maxillary palpi geniculate, 3-8 segmented; labial palpi 2-5 segmented. Wings, when present, large, broad and rounded apically; forewing with a heavy ring-vein and two longitudinal veins reaching from base to tip and each uniting with the ring-vein before tip; cross veins usually present; front margin of forewings without, or

with only a light fringe of hairs. Legs long. Ovipositor curved backwards.

In the species of all other Thysanopterous families the joints of the maxillary palpi never number more than three, and of the labial palpi never more than two, and it is on account of the abnormal number of their palpal joints that the *Æolothripid* genera forming the Nearctic division *Orothripinæ* are of such interest. In describing the genus *Stomatothrips*, Mr. HOOD makes some interesting generalisations on the probable evolution of the Thysanoptera, but of course, as HOOD admits, we require a great deal more material—or evidence—before we can usefully or safely make such generalisations.

KEY TO THE GENERA OF THE *ÆOLOTHRIPIDÆ*.

1. All antennal joints freely movable¹; joints of labial palpi fewer than in the maxillary palpi. 2
 Three or four terminal antennal joints closely united;
 maxillary palpi three-jointed, labial palpi four-jointed
Æolothripinæ 6
2. Maxillary and labial palpi 8-5, 8-3 (or 4), or 7-5 jointed respectively. (Genera Nearctic.) **Orothripinæ** 3
 Maxillary and labial palpi 3-2 jointed . . **Melanothripinæ** 5
3. Palpi 8-5 jointed; wings expanded apically
Stomatothrips Hood.
 Palpi 8-3 (or 4) or 7-5 jointed; wings not expanded
 apically 4
4. Palpi 8-3 or 4 jointed; forewings with dark longitudinal bands along posterior margin; head longer than wide *Erythrothrips* Moulton.
 Palpi 7-5 jointed; forewings with dark cross bands
Orothrips Moulton.
5. Second antennal joint produced apically in the form of a tooth *Ankothrips* Crawford.
 Second antennal joint simple . . . *Melanothrips* Haliday.

¹ I have not seen a specimen of *Stomatothrips*, which is described as having antennal "segments 7-9, more or less compactly united."

6. Head longer than broad, last three joints of antennæ connate *Rhipidothrips* Uzel.
 Head transverse, last four joints of antennæ connate . . 7
7. Forewings with cross-veins *Æolothrips* Haliday.
 Forewings without cross-veins . . . *Franklinothrips* Back.

OROTHIRIPINÆ MIHL.

1. Genus **Stomatothrips** Hood, *Proc. Biol. Soc. Washington*, xxv., 1912.

Species: *S. flavus* Hood—Mexico.

2. Genus **Erythrothrips** Moulton, *U.S. Dept. Agriculture, Bureau of Ent., Tech. Ser.*, 21, 1911.

Species: *E. Arizonae* Moulton—Arizona and California, U.S.A.

3. Genus **Orothrips** Moulton, *l.c.*, *Tech. Ser.*, 12, 1907.

Species: *O. kelloggii* Moulton and var. *Yosemitii* Moulton—California, U.S.A.

MELANOTHIRIPINÆ MIHL.

4. Genus **Ankothrips** Crawford.

Ankothrips Crawford, *Pomona Journ. Ent.*, ii., Mar. 1910.

Dicranothrips Trybom, in Schultze, *Zool. und Anthrop.*

Ergebnisse einer Forschungsreise im westlichen und zentralen Südafrika, 1903-5. Jena 1910.

Prionothrips Schille, *Acad. Litt. Cracov.*, xlv., 1910.

Species: *A. robustus* Crawford (type)—California, U.S.A.

A. fissidens (Trybom)—S. Africa. *A. niezabitowskii* (Schille)—Central Europe.

5. Genus **Melanothrips** Haliday, *Ent. Magazine*, iii., 1836.

Species: *M. fuscus* (Sulzer) (type)—Europe, N. Africa. *M. ficalbii* Buffa—Italy, England (1913).

ÆOLOTHIRIPINÆ MIHL.

6. Genus **Rhipidothrips** Uzel, *Mon. der Ordnung Thysanoptera*, 1895.

Species: *R. gratiosa* Uzel (type)—Europe (Bohemia, England).

R. niveipennis Reut.—Finland.

7. Genus **Æolothrips** Haliday, *Ent. Magazine*, iii., 1836.

Species: *Æ. fasciatus* (L.) (type)—Europe, North America, Africa. *Æ. bicolor* Hinds.—Massachusetts, U.S.A. *Æ. albocinctus* Hal.—Europe. *Æ. melaleucus* Hal.—Europe. *Æ. versicolor* Uzel.—Europe. *Æ. vittatus* Hal.—Europe. *Æ. tibialis* Reut.—Finland. *Æ. kuwanaii* Moulton—California, U.S.A. *Æ. vittipennis* Hood—Washington, D.C., U.S.A. *Æ. crassus* Hood—Illinois, U.S.A. *Æ. tilice* Bagn. (1913)—Norway.¹

8. Genus **Franklinothrips** Back.

Æolothrips (in part) Crawford & P. R. Jones.

Franklinothrips Back, *Ent. News*, xxiii., 1912 (Feb.)

Mitothrips Trybom, *Ent. Tidskr.*, 33, 1912.

Species: *F. vespiiformis* (Crawford) (type)—Nicaragua. *F. nasturtii* (P. R. Jones)—California, U.S.A. *F. megalops* (Trybom)—British East Africa. *F. longiceps* (Crawford)—California, U.S.A.

¹ Described in a paper appearing in forthcoming number of the *Journal of Economic Biology*.

ON ARIXENINA BURR, A SUBORDER OF DERMAPTERA.

By MALCOLM BURR, DOVER, AND K. JORDAN, TRING.

(Text-figs. 12-28.)

IN 1909 the senior author described a new dermapterous insect which he called *Arixenia esau* on account of its anomalous structure and the hairiness of its body and appendages. The build of the species is so strange among the Earwigs that *Arixenia* was placed by JORDAN into a family of its own, for which BURR in 1911 erected the new suborder ARIXENINA. In the account of the morphology and anatomy of *Arixenia esau* the agreements with and differences from the true Earwigs on the one hand and the African parasitic *Hemimerus* on the other were pointed out, and special attention was drawn to the primitive form of the hairy callipers, the reduced eyes, and the peculiar structure of the mandibles.

This remarkable apterous insect was found by the taxidermists Messrs. EDW. GERRARD and SONS, of Camden Town, in the breast-pouch of a specimen of the naked bat, *Cheiromeles torquatus*, collected in Sarawak by Mr. CHARLES HOSE. Four specimens in all were obtained. They proved to be immature, but two were much more advanced in development than the other two. It appeared to follow from the strange place where the specimens were discovered, as well as from the great reduction of the eyes, that *Arixenia* was parasitic or semiparasitic on *Cheiromeles*, and the contents of the gut showed the diet of *Arixenia* to consist, at least partly, of insects.

The specimens being immature, the intestines more or less decomposed, and the breast pouch of *Cheiromeles* a strange place for an insect in which to live, several points of importance required further investigation—particularly the questions whether (1) the adult *Arixenia* differed essentially from the immature individuals, (2) the organs of reproduction were of the ordinary

dermapterous types or exhibited peculiarities such as are found, for instance, in *Hemimerus*, and (3) the occurrence of *Arixenia* in the breast-pouch of the naked bat was accidental or whether there existed really such a close association between this insect and the bat.

Several more examples of the naked bat (in alcohol) were examined and instructions sent to some naturalists residing in the Malayan countries, all without result. You can imagine the pleasure it gave us when last winter (*i.e.* winter 1911-12) BURR received from E. JACOBSON a consignment of Dermaptera, which turned out to consist of adult and immature examples of a species of *Arixenia*. Herr E. JACOBSON, on being told of the great interest attaching to the specimens, sent a report on his captures and very kindly put a large number of specimens in alcohol and some pinned ones at our disposal. We had hoped that he would be able to attend the Congress, and to give personally an account of his discovery, but he had to return to Java before the date of the Congress, not without promising, however, that he would again visit the place where he found *Arixenia*, and, if possible, provide us with all the stages of growth in a sufficiently good state of preservation for a more minute anatomical examination than the present, more or less decayed, specimens will admit.

E. JACOBSON gave us the following report on his captures :

"This remarkable species (of which I am sending you thirty-five specimens besides a number of damaged ones) was found by me in a cave near the sea-shore at Babakan (Banjoumas Residency, Java). The cave is called by the natives *Gouwa Lawa*, which means *bat-cave*, on account of the tremendous number of bats which frequent it. The cave is a narrow cleft in the rocks, about forty to fifty metres deep and of about the same height. The floor is covered with a thick layer of guano from the bats. This accumulation of excrements serves as food to a large number of insects. The mass is all alive with the larvæ of beetles and flies, more particularly a kind of *Trox* and different species of *Tenebrionidæ*. The curious caterpillar of a moth, carrying its own cocoon, which has the shape of a mussel, is found there in great numbers.

"The most conspicuous insects inhabiting the cavern are,

however, the Earwigs mentioned above ; they crawl in countless numbers on the surface of the guano and everywhere on the rocky walls. Evidently they live on the various larvæ feeding on the guano, but besides this, they are constantly waging a terrible war against each other, the victors devouring the bodies of their slain mates. Especially those which have just moulted, their skins still being soft and of a yellowish white colour, are hunted down by those in a more advanced state of maturity.

"Copulating couples could be seen everywhere, their heads turned opposite ways, and one of them pulling the other backwards. I have seen several times couples of which one had freshly moulted attacked by other individuals, killed and torn to pieces, while they were still united.

"A more loathsome spectacle than these thousands of ugly, hairy creatures, running about hither and thither, fighting and devouring each other, can hardly be imagined.

"The species cannot be called true cavernicolous, as the part of the cave where the specimens were found was not quite dark, being situated only about twenty metres from the high entrance of the cave.

"It is very curious that, although three other caves inhabited by numerous bats are found quite near to the Gouwa Lawa, these Earwigs were not observed in any of them.

"The cave where I found the *Arixenia* is on the south side of the Goenong Solok, a quite isolated range of hills lying in the south-eastern part of the Residency of Banjoumas (Central Java), on the left bank of the Kali (= river) Bengawan at the sea-shore, which in that place consists of nearly black 'magnetic-iron sands.'

"I do not understand what the larvæ found in the goular pouch of the bats from Sarawak were doing there. If they live on guano, it would not be necessary for them to visit the bats themselves, as they could find all they desired in great quantity on the floor of the caves. Could it be possible that the larvæ are attracted by the exudations from the glands in the goular pouch of the bat ? Or do the larvæ simply use the bats as means of conveyance to reach new localities ? You are perhaps aware that it has been observed that some kinds of *Acari* are transported by fleas, without being parasites of the latter, and that,

moreover, Mallophaga make use of *Hypoboscidae* for transportation from one bird to the other."

E. JACOBSON will this time endeavour to supplement this interesting account by trying to obtain the bat which frequents the cave and by making further observations on the habits of *Arixenia*.

Although JACOBSON'S specimens very closely resemble *Arixenia esau* in facies, a cursory examination convinced us at once that they represented a different species, which has since been described as

Arixenia jacobsoni Burr (1912).

The species is easily distinguished from *A. esau* Jord. (1909) by the pro- and mesonotum being truncate posteriorly instead of being rounded, and by the greater length of the thoracical sterna, both in the adult and immature individuals. These external distinctions are not very trenchant and, considering that the species of insects inhabiting the Malayan countries are as a rule split up into a number of geographical races, would hardly justify a specific separation of *jacobsoni* from *esau*. However, a closer examination of the morphology and anatomy has revealed so many differences that the two forms must be considered as distinct species.

The discovery of adult specimens has enabled us to fill the lacunæ in our knowledge of the general build of *Arixenia*, the main point being this, that the adult examples do not essentially differ from the immature stages, apart from the size, the reproductive organs, and the antennæ. The details of the morphology and anatomy which JORDAN has published of the immature *Arixenia esau*, therefore, may be accepted as applying on the whole also to the still unknown imago of that species. On the other hand, the description of the mouth-parts, gut, and some other organs of *A. esau* does by no means fit *A. jacobsoni*, the divergency between the two species being greater than one would expect from the close agreement in external features.

Head.

The head of *Arixenia* offers an interesting mixture of typical Earwig characteristics and of peculiarities restricted to this

genus. The head-capsule has the more or less cordiform shape generally found in Dermaptera, but is unusually short and broad, and proportionately much larger than in true Earwigs. It is shorter in *jacobsoni* than in *esau* on account of the anterior or clipeal portion being somewhat reduced in a longitudinal direction. For this reason the suture separating the labrum from the head is nearer the antennæ in *jacobsoni* than in *esau*. The sutures which separate the clipeus from the frons (=epicranium) and the latter from the occiput (=protocranium) are but slightly marked in *Arixenia*, being particularly indistinct in *jacobsoni*, and in both species much less in evidence than in many true Earwigs. The posterior angles of the head bulge out considerably, the cavity thus formed serving for the accommodation of manducatory muscles. The grooves on the occiput, which indicate externally the points where the upper posterior processes of the endoskeleton (=tentorium) are fastened to the capsule, are well indicated in both species. Such a large development of the frontal region and the mouth-parts is unknown among true Earwigs.

The eye is rather smaller in *A. jacobsoni* than in *A. esau* and further differs in shape, being elliptical in *esau* and slightly but distinctly reniform in *jacobsoni*. The number of facets is eighty odd in the former and about seventy in the latter, being in both species very much smaller than in any known true Earwig. The reduction is accounted for by the habits of the insects, cave-dwellers generally having atrophied or reduced eyes.

The segments of the antenna increase in number during the metamorphosis from eight to thirteen in the larval stages, and fourteen in the imago, which is the usual type of development in Earwigs, the increase taking place by a division of the third segment. The first segment is essentially shorter than in *A. esau*, being cylindrical and practically straight in *jacobsoni* and more distinctly curved in *esau*. The antenna of *jacobsoni* has free play forward and backward, whereas the first segment of *esau* cannot be directed straight forward—at least so it appears from the alcohol specimens. Besides the patches of sensory pits observed on each segment of the antenna of *esau* with the exception of the two proximal ones (and also more or less developed in the same way in true Earwigs), the segments

have in *jacobsoni* on both the upper- and underside a few larger pits with blackish rims, these pits being placed towards the base on the proximal segments and nearer the apex on the distal ones. The fourth segment is about one-third shorter than the third, and this as long as the fifth in *jacobsoni*, while in *esau* the fourth equals the fifth and both together are a little shorter than the third. The relatively small number of segments and the lengths of the antenna recall the higher Dermaptera or Eudermaptera rather than the Protodermaptera.

As the development of the mouth-parts and the gastronomy of a species are interdependent, a comparison of these organs in the two species of *Arixenia* is of special interest. If the habits of *esau* and *jacobsoni* are really different, as the occurrence of the former in the breast-pouch of *Cheiromeles* and of the latter as a free carnivore in a cave suggests, the mouth-parts must be expected to differ, and, inversely, if they differ, we must conclude that the habits are not the same. The differences in the mouth-parts are much greater than we anticipated. It is particularly the strong development of the mandibles as organs for seizing the prey and cutting it up in which *jacobsoni* deviates very widely from *esau*, and this development carries with it a corresponding modification of the other appendages. The large mandibles are covered by an enlarged labrum, and the greater length of the labrum

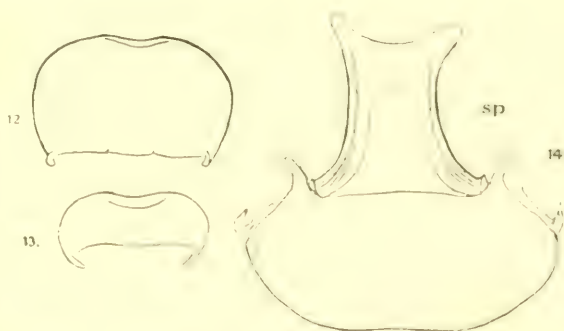


FIG. 12.—Upper lip of *Arixenia jacobsoni*.

FIG. 13.—Upper lip of *Arixenia esau*.

FIG. 14.—Ninth abdominal sternite of *A. jacobsoni* ♂.
sp., support of penis.

is compensated for by a corresponding reduction of the clipeus. The proportional length and breadth of the labrum are 1 : 2.8 in *esau* and 1 : 1.8 in *jacobsoni*, i.e. the upper lip is nearly three times as broad as it is long in *esau* (text-fig. 13) and less

than twice as broad as long in *jacobsoni* (text-fig. 12). The general shape and structure are the same in the two species, the anterior edge appearing slightly incurved on account of its central portion being bent downward. There are a greater number of moderately small bristles in between the larger ones in *jacobsoni* than in *esau*, which is also the case on other parts of these insects, but the anterior edge of the labrum bears more bristles in *esau* than in *jacobsoni*.

In his account of the morphology of *A. esau* JORDAN laid special stress on the peculiar development of the mandibles, which differ very remarkably from those of other Dermaptera. The new *Arixenia* proves these organs to be strongly susceptible to modification. This fact is well known in many other groups of insects; but the mandibles of the Dermaptera have not yet been studied comparatively. They are concealed by the upperlip and can only be seen without much trouble in specimens preserved in alcohol, which allow of the upperlip being lifted up. The series of dermapterous mandibles which our figures 15-19 represent is of some interest from the view-point of comparative morphology. The usual type as represented by the common Earwig (*Forficula auricularia*) is triangular and more or less strongly flattened in a dorso-ventral direction, with the tip pointed (text-fig. 15). The tip is divided into two teeth, which appears to be characteristic of all Dermaptera inclusive of *Hemimerus*. The inner or masticating edge of the mandible is widened in *Forficula* (text-fig. 15) into a low and long double ridge (= dorsal and ventral edges) and bears proximally to this ridge a few bristles. The mandible of *Hemimerus* (text-fig. 16) is similar, but the ridge terminates proximally in the shape of a tooth, and the bristles are slightly more numerous. In *Arixenia jacobsoni* (text-figs. 17 and 18) the mandibles are very large and strong, the two apical teeth are long and sharp, and the median tooth is large and curved in the right mandible (text-fig. 18) and shorter and more regularly triangular in the left one (text-fig. 17). The tooth of the left mandible is divided by a notch, the two tips corresponding to the double tooth occurring in Earwigs. Moreover, the setiferous portion of the inner edge is much more extended than in *Forficula* and *Hemimerus*.

It is a long jump from the *jacobsoni*-mandible to that of *esau* (text-fig. 19), and we must expect that a species will be discovered which bridges over this wide gap. The homology of

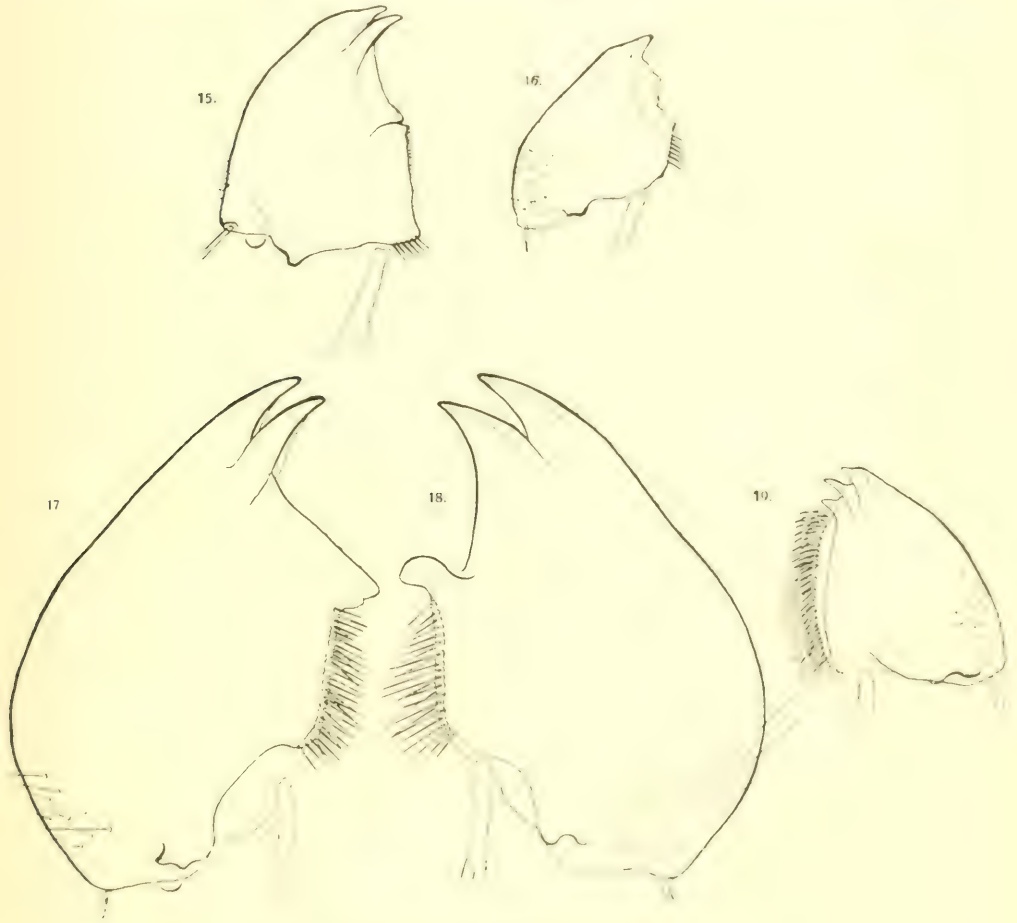


FIG. 15.—Mandible of *Forficula auricularia*.

FIG. 16.—Mandible of *Hemimerus talpoides*.

FIG. 17.—Mandible of *Arixenia jacobsoni* (left side).

FIG. 18.—Mandible of *Arixenia jacobsoni* (right side).

FIG. 19.—Mandible of *Arixenia esau*.

the various portions of the *esau*-mandible is quite clear. The mandible is reduced in size, being very much smaller as compared with the size of the specimens than in any other Dermapteron

we have compared. The second feature which strikes one as remarkable is the possession of three apical teeth instead of two. A comparison with the other mandibles figured renders it evident that the third tooth is the tooth placed in *jacobsoni* about the centre of the mandible. This tooth is pushed apicad in consequence of the excessive development of the setiferous portion of the inner edge in *esau*. This portion of the edge is rounded, and the distal bristles are modified into strong flexible spines, which are curved at the apex. The bristles remind one strongly of the maxilla, and there can be no doubt that the work the *esau*-mandible has to accomplish differs in some essential point, probably in the kind of food to be seized and masticated, from the work the *jacobsoni*-mandible has to perform.

The remaining buccal organs (text-figs. 20, 21, 22) are likewise different in *A. esau* and *jacobsoni*. The first maxilla of *jacobsoni* is particularly distinguished from that of *esau* in the armature of the inner lobe. In all Dermaptera (as far as they have been examined with regard to their mouth-organs) inclusive of *Arixenia*, the lacinia bears two apical teeth like the mandible, excepting *Hemimerus*, which has four teeth. In *jacobsoni* these teeth are almost conical, while they are concave beneath and therefore more nearly shaped like the claws of a dog in *A. esau*. The apical half of the inner surface is flat, with both the dorsal and ventral edges cariniform and furnished each with a row of bristles, there being no bristles in between these two longitudinal rows, while the proximal portion of the inner surface is irregularly covered with bristles. The lacinia (c 1) of *jacobsoni* is slenderer than in *esau*, its inner surface being concave with the exception of the proximal portion, whereas it is convex in *esau*. The apical teeth and the distal bristles are longer and slenderer, and the dorsal seriated bristles are quite different from the ventral ones, while the two rows are practically alike in *esau* (text-fig. 20, c 1). The outer lobe (= galea) of the first maxilla (c 2), apart from its larger size and the slightly increased number of bristles in *jacobsoni*, agrees in the two species. The maxillary palpus, however, is again essentially different, the bristles being more numerous in *jacobsoni*, the segments much longer and their proportions different. Segments 2, 3, and 4 are of equal width in *esau* (15 : 15 : 15), while in *jacobsoni* the fourth

is much smaller than the two preceding ones, the proportional lengths being 30 : 30 : 22 (cf. text-figs. 20 and 21). The accessory apical segment (podotelson of VERHOEFF), characteristic of all Dermaptera and apparently only found in this order, is present in both species of *Arixenia*, as it is in *Hemimerus*.

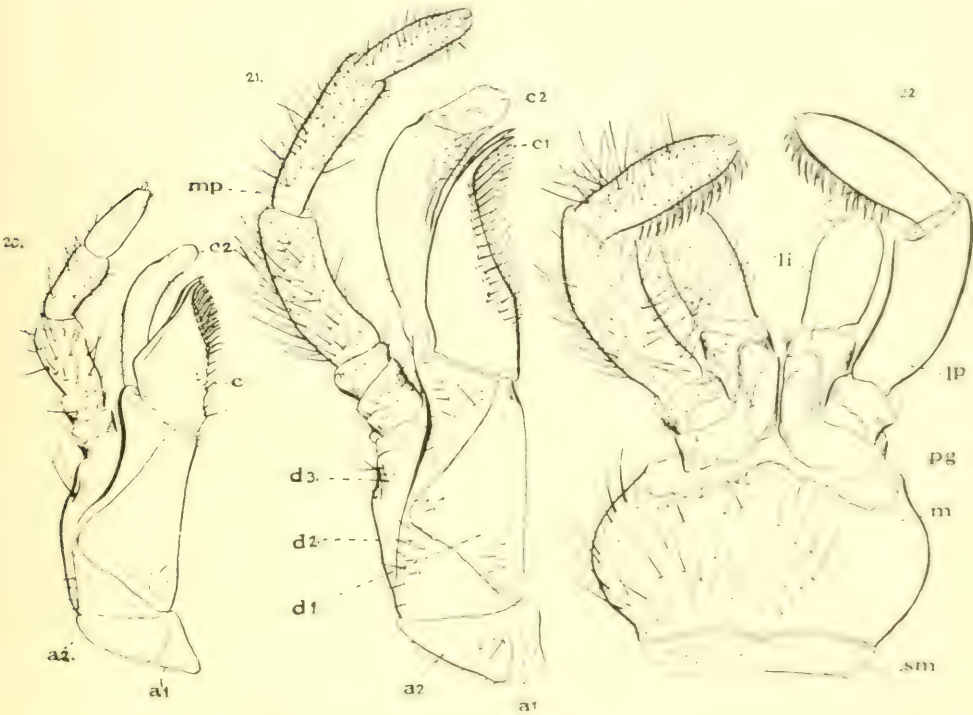


FIG. 20.—First maxilla of *Arixenia esau*.

FIG. 21.—First maxilla of *Arixenia jacobsoni*.

FIG. 22.—Second maxilla of *Arixenia jacobsoni*.

a¹ and a², the two sclerites of the cardo; d¹, d², d³, the three parts of the stipes; c¹, lacinia; c², galea; mp, maxillary palpus; lp, labial palpus; pg, palpiger; m, mentum; sm, submentum; li, ligula.

The second pair of maxillæ, the labium and its appendages (text-fig. 22), has the general facies as in other Dermaptera. It differs in the two species of *Arixenia*. The most proximal sclerite, the submentum (sm), which forms the posterior margin of the head-capsule on the undersurface, is a narrow transverse plate in both species. The mentum (m) is decidedly shorter

in *jacobsoni* than in *esau*, and the labium proper and the palpi correspondingly longer, as in the case of the clipeus and labrum on the upperside of the head. The hind margin of the mentum is somewhat angulate in the centre in *jacobsoni*. The apical segment of the labial palpus, in contradistinction to *esau*, bears on the inner surface a number of strong, sharply pointed, spine-like bristles, which are curved proximad, not being directed distad like the ordinary slender bristles which are placed on the lateral and outer surfaces (text-fig. 22, lp). The ligula (li) is divided down to the mentum much as in *esau*, but its apical segment is rather longer than in that species. Above the ligula there is a membranous cone which forms the lower wall of the mouth. The upperside of this cone is divided into three small lobes of nearly equal length, the hypopharynx or endolabium, the lateral lobes partly covering the median one, as figured by JORDAN (1909). In *esau* these lateral lobes slightly curve sideways, whereas in *jacobsoni* they are more symmetrically rounded.

Thorax.

The thorax of *Arixenia* is of the same type as in wingless Earwigs. The notal plates, however, are more independent, and less closely imbricated together. In *esau* the three tergites are slightly convex with the lateral margins rounded and feebly widened out, the pro- and mesonota being also rounded posteriorly. In *jacobsoni* the pronotum is distinctly truncate and therefore does not exceed the mesonotum so much in length as in *A. esau*. Moreover, all three nota have broadly explanate margins in *jacobsoni*, especially the pro- and mesonotum. These margins are distinctly curved upwards, being broader in the than in the ♂. The mesal line is strongly impressed on the pronotum, less so on the other two nota. It is curious to note that the differences between the uppersides of the two species are reversed on the underside. The sterna are narrower in *jacobsoni* than in *esau*, and the pro- and mesosterna are posteriorly narrowed and rounded, not being truncate as in *esau*. The short and broad sternal plates somewhat resemble those of certain rather peculiar apterous Protodermaptera, e.g. *Karschiellinæ* and *Parisolabinæ*.

The legs are more densely hairy in *jacobsoni* than in *esau* and somewhat longer, but the proportions and structure of the tarsal segments are almost the same in the two species. Although *Arixenia* is remarkably pubescent, the soles of the tarsi are less hairy than in true Earwigs. The claw-segment has no pulvillus and the claws are of the same form as in true Earwigs.

Abdomen.

One of the most important and interesting distinctions between the sexes of Dermaptera, and between the immature and adult females, is the great reduction in the adult female of the eighth and ninth abdominal tergites, which segments are not visible externally in the imago of that sex. As *Hemimerus* agrees in this respect with the other Dermaptera, it is very remarkable that in *Arixenia* both sexes have the full complement of tergites, the reduction of the tergites 8 and 9 being very slight in the female. This retention of a larval or ancestral character places *Arixenia* apart from all the rest of the order. Similarly, the callipers of *Arixenia*, too, are of a larval type, but this point *Arixenia* shares with *Hemimerus*, in which the callipers also do not assume the strongly chitinated polished type found in most adult true Earwigs, remaining hairy and being round in a transverse section. But the callipers of adult *Arixenia* are more earwig-like than those of *Hemimerus*. They are thickest at the base and taper to a point, the extreme tip being hard and naked. In the adult male they are directed at first outward and then bowed inwards at an obtuse angle. At this elbow (and beyond it) they bear on the inner surface short spine-like bristles which curve frontad and are doubtless of service in copulation (text-fig. 28). The callipers of the female and all immature stages are almost straight. There is no trace of segmentation in the larvæ and adult. These forceps are too long and weak in both sexes for being effective weapons of offence or defence. In those Earwigs in which the forceps are apparently useless as weapons, they are highly specialised in the male for sexual purposes. We must look upon the callipers of *Arixenia* as being either very primitive or extremely degenerate.

The posterior segments of the abdomen situated in between

the callipers and beyond their bases are of special interest in the classification of the Dermaptera, being as a rule different in the sexes. Segment 10, which is proximal to the forceps, is shorter than is usual in Earwigs and bears a rounded median groove in both sexes of *Arixenia*. Segments 11 (= pygidium) and 12 (= metapygidium) are completely fused and form a single sclerite, which, in the ♂, is slightly convex in a sagittal sense and has a round groove dorsally and a less distinct one ventrally. In the ♀ (text-fig. 23) it is produced into a four-sided pyramid with blunt edges and an elongated dorsal groove and a vestigial round ventral one.

The apex of the pyramid is sometimes slightly upturned, and the sides are concave proximally for the reception of the callipers. The last or supra-anal tergite (= telson, text-fig. 23, tels) is a well-developed transverse plate separated from 11 and 12 by a suture as distinct as the one between segments 10 and 11. There are no tubercles and no stink-glands on the abdomen.

The abdominal sternites 2 to 9 in the male and 2 to 7 in the female are essentially as in other Dermaptera, the first sternite being absent everywhere in the order. The sternite of segment 9 differs in the male, and in this sex only, from the previous sternites in bearing joined to its anterior edge a special sclerite, which is large in *Arixenia*, being a little longer than sternite 9 and less than half the width of that segment. This accessory plate is also found in true Earwigs, apparently being different according to species, sometimes large, sometimes vestigial. In *Arixenia* (text-fig. 14) it is almost membranous with the exception of the edges, which are strongly chitinised. The lateral margins are narrow strips of chitin which curve outward posteriorly, here joining a projection from inner (= anterior) margin of the ninth sternite. The proximal margin of the plate is incurved, a kind of fork being formed in which rests the organ of copulation. The sclerite, being somewhat curved upwards and movable up and down, appears to functionate as a support for the penis and a manubrium to the ninth sternite. The muscular attachment has not yet been examined. A comparative study of this support in the Dermaptera would be of interest and might furnish important taxonomic characters.

Supragenital plates are absent in the male of *Arixenia*, and the sclerites usually present in both sexes of Dermaptera between the tenth tergite and the base of the callipers on the one hand, and the anus on the other, are but feebly developed. There are

two of them on each side of the body. One is a mere membranous fold, lying at the base of the calliper and being a little more strongly chitinised only near the supra-anal plate (tergite 13). This is presumably the coxopodite of the calliper. The other sclerite is larger and hairy, representing the tenth sternite (text-fig. 23, st. 10). The anus is flanked by a membranous swelling on each side, a

third and fourth swelling being placed in front of and behind the anus, the former pair bearing a few minute hairs (text-fig. 23).

In the female the sclerite which we regard as the coxopodite of the calliper is yet more indistinct than in the male, and the tenth sternite is so much fused with the tenth tergite that the suture has almost disappeared proximally. In both sexes the inner portion of the tenth sternite is membranous, while the apex is more strongly chitinised in the female than in the male.

The seventh sternite is, as in other Dermaptera, the largest of all, and has the apical margin visibly emarginate. Dorsally

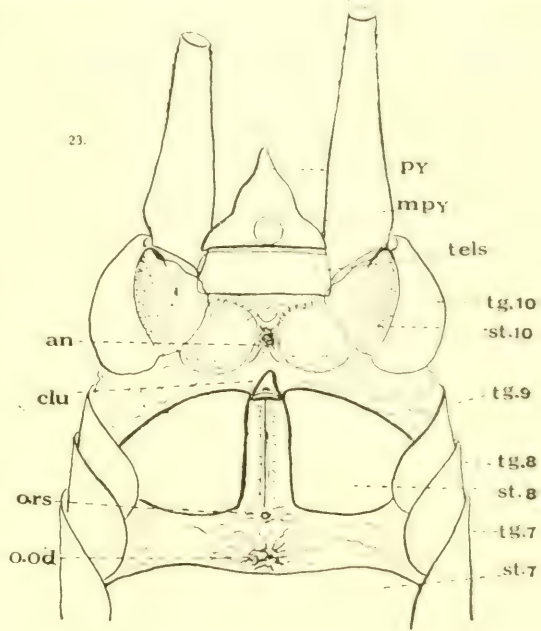


FIG. 23.—Tail-end of *Arixenia jacobsoni* ♀, ventral view. py, pygidium; mpy, metapygidium; tels, telson (= tergite 13); tg.7, tg.8, tg.9, tg.10, tergites 7 to 10; st.7, st.8, st.10, sternites 7, 8, and 10; an, anus; clu, clutch; o.rs, orifice of receptaculum seminis; o.od, orifice of oviduct.

of it, *i.e.* below it if the specimen is examined upside down, we find the orifice of the oviduct. Farther back we find two large genital sclerites, which we consider to be the eighth sternite. The plates are strongly chitinised and hairy, being larger than it is known of any other Dermapteron (text-fig. 23, st. 8). The two sclerites border a median longitudinal groove, at the proximal end of which the orifice of the receptaculum seminis is situated (o.rs). The groove is membranous, but terminates anally in a triangular, obtuse, horizontally flattened sclerite, which is a solid piece of chitin and serves as a grip or clutch (clu) for the male armature in copulation, as we shall describe farther on. The proximal edge of the clutch is raised, and the anterior vertical surface thus formed is concave, there being also a groove, a deep one, behind this ridge; sometimes the ridge is distinctly enlarged backwards over this groove, the clutch appearing doubled up horizontally. We have not found any gonapophyses.

Respiratory and Nervous Systems.

The adult and immature *A. jacobsoni* agree with the immature *A. esau*. The main chain consists of eleven ganglia, and there are ten stigmata (cf. JORDAN, 1909).

Alimentary Canal.

The main divisions of the alimentary canal observed in Dermaptera generally are also found in *Arixenia*. Both sexes of *A. jacobsoni* have the same very long and large œsophagus as in *A. esau*, upon which follows the short proventricle. The middle gut is widened at its commencement in both species into a large sack extending towards the right side. While the posterior portion of this stomach, however, is coiled up spirally in three convolutions in *A. esau*, this is not the case in *A. jacobsoni*, and we observe this noteworthy fact that in the immature *jacobsoni* (one examined, sex not known) and in the males (several examined) the stomach makes one and a half to two coils, whereas in the female (two examined) there are no convolutions. In this sex the middle gut and the small intestine form an elbow, the small intestine being again elbowed a short distance from its junction with the stomach. These differences in the shape of the stomach between the sexes of *A. jacobsoni* and between

A. jacobsoni and *A. esau* are interesting from several points of view. They prove above all the occurrence of specific and sexual differences in internal organs apart from the reproductive system, and render it certain that an examination of these organs for systematic purposes would be fruitful. We know as yet very little about the individual, seasonal, geographical, and specific variation of the internal organs of insects; insect-systematics are still essentially a science of external features.

Sexual difference in the shape of the stomach was not known of Earwigs. However, only a few forms have been examined anatomically, and it is therefore premature to say that *Arixenia* is an exception among Dermaptera.

A further point of interest is this, that the male and not the female has the same form of stomach as the immature *Arixenia*. The simplification of the stomach in the female, however, may be a secondary acquisition due to the large development of the ovaries in the gravid female.

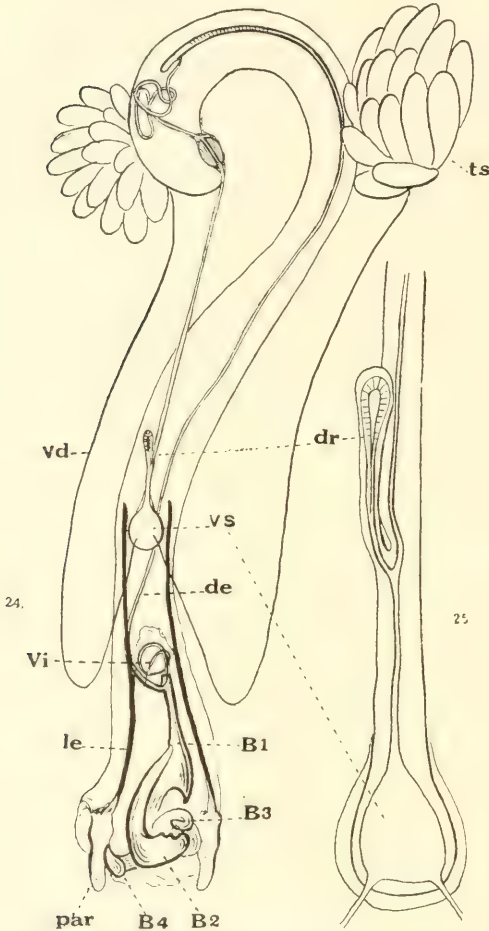
Reproductive System.

As the specimens of *Arixenia esau* described in 1909 were all immature the reproductive organs of the genus remained unknown. We were naturally very interested to know whether this anomalous Dermapteron exhibited any such striking characteristics in these organs as for instance the viviparous *Hemimerus*, or whether they were of one of the usual Earwig types.

The organs of reproduction vary to a great extent in the Dermaptera, and not only furnish reliable distinguishing characters as regards species, but in many cases are also the safest guides in establishing the relationship of the species and genera, *i.e.* in drawing up a classification. VERHOEFF was the first to make use of them for the grouping of the species and genera, and ZACHER (1911) adopted that method in his important work on the Protodermaptera and other contributions to Dermapterology. The reproductive organs of *Arixenia* are of an Earwig type, but exhibit important peculiarities.

The quantitatively chief part of the male reproductive system of *Arixenia* is a large compact organ of copulation or penis, which extends to the basal third of the abdomen and is curved in crook-shape at its proximal end (text-fig. 24). The testicles are

closely applied to this curved base of the penis, the right one generally lying on top of the organ, more or less covering the



FIGS. 24 and 25.—Reproductive organs of *Arixenia jacobsoni* ♂. ts, testis; vd, vas deferens; de, ductus ejaculatorius; Vi, apex of same; vs, vesicle; dr, atrophied duct; par, paramere; le, lever of paramere (abbreviated); B¹, B², B³, B⁴, genital armature.

space encircled by the crook, but sometimes being so far moved sideways as it is drawn in our figure. Each testicle (ts) contains sixteen follicles, which are rounded distally and narrowed towards the common duct. The follicles are pressed closely together and form a compact body, the apical and dorsal surfaces of which resemble to some extent a compound berry. In the structure of the testicle *Arixenia* essentially differs from *Hemimerus* and the Earwigs (as far as they have been examined), the testis of these insects being composed of one or two follicles rolled up. The very slender vas deferens (vd) originates at the ventral side of the testis and runs straight backwards to near the

rectum and then curves forward.¹

¹ In *Forficula* and a few other Earwigs dissected by me the vas deferens is also straight, not being coiled up as drawn by the earlier authors.—K. J.

The two vasa deferentia join a rounded vesicle (vs) which lies on top of the organ of copulation and from which a single ejaculatory duct (de) runs frontad, entering the penis close to the tip. About one-sixth the way from the vesicle forward the duct throws off a small short duct (dr), widening at the apex. This blind branch (text-fig. 25, dr) is evidently the remnant of the second ejaculatory duct present in the primitive Earwigs. The duct, on entering the organ of copulation, is enlarged to a small elliptical vesicle with very thick walls of longitudinal muscles and then forms several loops before joining the more strongly chitinised ejaculatory duct of the copulation-organ.

While the penis is flat in the Earwigs and *Hemimerus* in a dorso-ventral sense, it is cylindrical in *Arixenia*, widening at the apex. It is composed of two bundles of transverse muscles, which form the lateral and ventral walls of the cylinder, and a bundle of longitudinal muscles, which forms the dorsal wall. Upon this dorsal bundle there lies a transparent membrane expanded between two wire-like, strongly chitinised rods (le), which run parallel from the proximal end of the penis to near the apex, somewhat diverging distally, and act as a lever or manubrium to the parameres (par). The two parameres of the Earwig-penis consist of a weakly chitinised proximal and a more strongly chitinised distal portion, the latter usually being armed with one or two teeth or hooks. In *Arixenia* the parameres are very weak. The apical piece is subcylindrical, finger-shaped, feebly chitinised, and studded with blunt sensory setæ resembling papillæ. The right and left rods of the before-mentioned lever (le) join the end-piece of the paramere of their respective sides at its lateral surface, the rod being here flattened and firmly fixed to the paramere. The end-pieces of the parameres being dorso-lateral, the apical cavity of the penis called the præputial sack (VERHOEFF) lies ventrally to them. The præputial sack of *Arixenia* is deeper than the penis is broad, and contains a special armature consisting of four very strongly chitinised and irregularly shaped curved bars (B^1 – B^4) with rounded as well as pointed projections. The armature looks different according to the side from which it is examined. A distal projection (B^4) resembles more or less the neck, head, and beak of a bird, and there is another pointed hook, but reversed, farther proximally (B^1).

This armature is joined by the ejaculatory duct (de), a chitinous tube lying in between the three bundles of muscles described above. The tube, or rather its walls, slightly widens distally and proximally and enters the præputial sack from the ventral side, curving upwards and being united with a longitudinal bar, which projects proximad beyond its junction with the duct. A complex armature of the præputial sack is rather rare among Earwigs, being known in a small number of genera among the Protodermaptera: *Gonolabis*, *Bormansia*, *Karschiella*, etc., and we may anticipate the armature of *A. esau* to be quite different from that of *A. jacobsoni*.

Although the tubular rod containing the ejaculatory duct joins the armature contained in the præputial sack, the duct itself does not do so, but leaves the rod and makes several irregular convolutions at the bottom of the præputial sack (at Vi, text-fig. 24).

On the ventral side of the præputial sack there is a second cavity, in funnel-shape, narrowing to a point proximally. Its dorsal wall is continuous only at the apex with the ventral wall of the præputial sack, the funnel being otherwise independent of the præputial sack. As its sides are distally connected with the end-pieces of the parameres, the ventral and lateral walls of the funnel may be homologous to the proximal segments of the two parameres being fused together. The tip of the funnel receives a thin tube which runs along the whole length of the organ of copulation and is possibly a reduced second ejaculatory duct, the funnel in that case being its præputial sack. We have not found a connection between this tube and the ejaculatory duct, but further investigation may prove the tube to be thrown off from the duct at the proximal end of the penis where the duct is irregularly coiled up. There is no armature in this funnel.

As regards the reproductive organs of the female two main types of ovaries are known among Dermaptera. The one type is represented by *Forficula auricularia*, in which the two oviducts—which are united distally and receive here the duct of the receptaculum seminis—bear each three rows of ovarian tubes containing one egg each. The second type is exemplified by *Labidura riparia*, in which each duct bears only one row of egg-

tubes. The ovaries of *Arixenia* (text-fig. 26) and *Hemimerus* are of the second type. In both genera there are but few ovarian tubes, each of which matures only one egg-cell, and the wall of the oviduct is very thick and folded to admit considerable expansion.

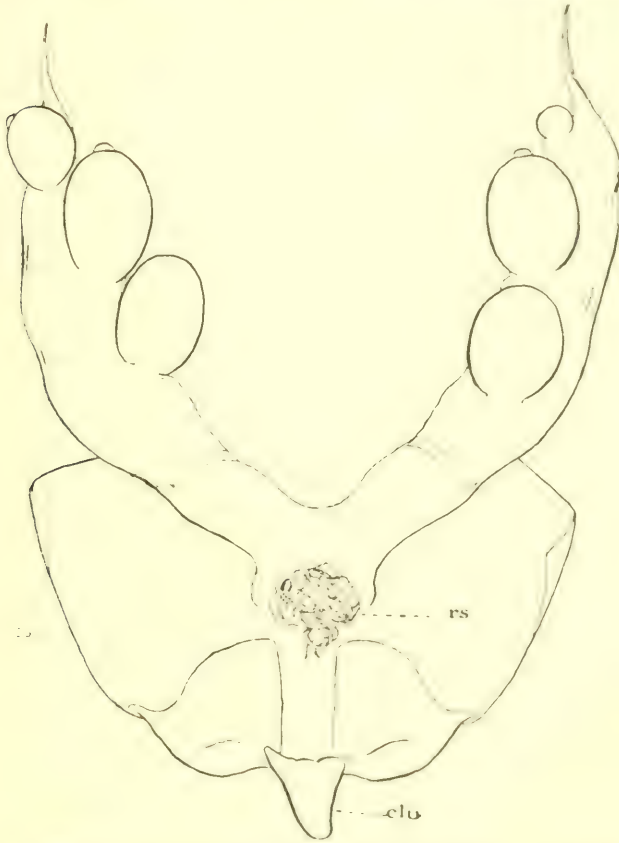


FIG. 26.—Reproductive organs of *Arixenia jacobsoni* ♀. rs, receptaculum seminis; clu, clutch.

When first examining the ovaries of *Arixenia* I had before me only one specimen and the torn-off tail-end of another female, and these gave me the impression that *Arixenia* was oviparous, but produced an uncommonly large egg. On applying to Herr JACOBSON for some more females I promptly received several examples of both sexes (of the original batch), which enabled me to rectify my statement expressed at the Congress. *Arixenia*

is *viviparous* like *Hemimerus*. Probably no true Earwigs are viviparous. There are two mature females in this consignment, both caught in copula, their broken-off tail-ends still being firmly fixed to the likewise broken-off tail-ends of the males. The soft parts of the specimens are strongly macerated. One of the tail-ends contains a large embryo, a second embryo projected from the female which is the owner of the tail-end (according to the number of segments in the tail-end and the remainder of the abdomen on the specimen), and two more were floating in the tube. These embryos are all of the same size, and apparently almost full-grown, chitinisation being well advanced. Their callipers are not segmented. Judging from the tissues projecting from the one female and the corresponding tail-end, the four embryos belong to this one specimen. What is left of the ovaries contains several small egg-cells and one or two minute embryos—this observation, in connection with the fact that the pregnant female is in copula, rendering it evident that propagation extends over a considerable period in *Arixenia*, budding going on at the apex of the ovaries as the embryos nearer the orifice of the oviduct ripen. We have here a case of ovarian pregnancy similar to that of *Hemimerus*, but it remains to be seen whether there is, as in *Hemimerus*, an amnion, placenta, and vesicula cephalica.

The large opening of the oviduct lies in the membrane between the seventh and eighth sternites at a considerable distance from the latter when the segments are pulled apart (text-fig. 23, o.od). At the proximal end of the groove, flanked by the two halves of the eighth sternite (st. 8), we find the orifice (o.rs) of a gland which I consider as the modified receptaculum seminis (text-fig. 26, rs). In an abdomen not stretched out, but normally telescoped, the orifice of this gland lies above and behind the entrance to the oviduct. The supposed receptacle consists of a long tube coiled up and forming a fairly compact body on a short coiled-up stalk. There is no receptacle of the usual kind (sausage-shape). We find along the tube at short intervals large cells, which are, probably of a glandular nature. However, we are by no means sure about the function of the organ. In the two pairs sent in copula the tip of the penis reaches exactly to the orifice of the duct of this accessory organ.

In pairing, the præputial sack of the male is entirely reversed, what is its bottom in a rest-position (text-fig. 24) becoming the apex in copulation (text-fig. 27). The proximal bar

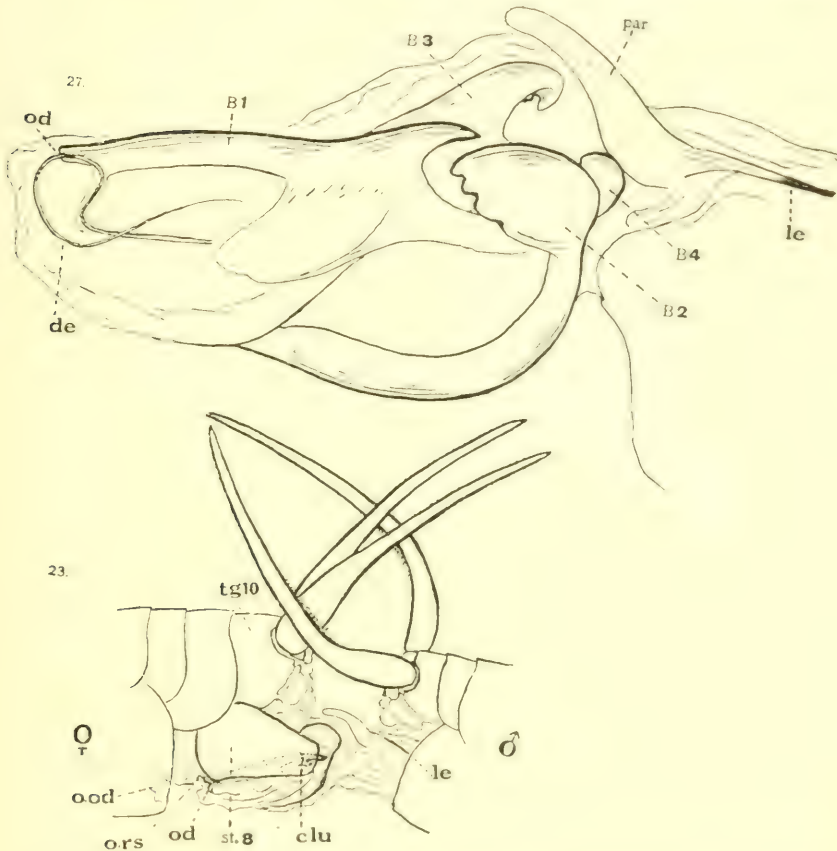


FIG. 27.—Genital armature of *Arixenia jacobsoni* ♂ thrown out from the præputial sack. B¹, B², B³, B⁴, the four sclerites; par, paramere; le, lever of same; de, apex of ejaculatory duct; od, the point where the duct leaves the armature.

FIG. 28.—Tails of ♂ and ♀ *Arixenia jacobsoni* in copula. tg, tergite 10; clu, clutch; o.od, orifice of oviduct; o.rs, orifice of receptaculum seminis st.8, sternite 8.

B¹ is now the most distal one; it lies during copulation (text-fig. 28) within the slit between the two halves of the eighth sternite (st. 8) of the female, and its hook catches the concave

frontal surface of the clutch (clu). The ejaculatory duct projects from the opening at od. The broad hook of bar B^2 is hollow, beneath and dentate, and catches hold of the apical margin of the left eighth sternite from the upperside. The hooks of B^1 and B^2 , standing opposite one another and facing opposite directions, secure a very firm hold (cf. text-figs. 27 and 28). Moreover, the apical hook of B^4 grips the apex of the clutch C of the female from above, pressing it down, counteracting the strain exercised by the hook of B^1 and thus preventing this hook from slipping off the anterior surface of the clutch. The bar B^3 lies against the margin of the right half of the eighth sternite. The parameres (par) do not play any part in holding the female. They appear to be, in *Arixenia*, tactile organs rather than claspers. Their soft texture and minute papillæ-like hairs point in that direction.

The above-mentioned embryos, which have already a coat of brown hairs, are curled up in the usual way, the callipers lying on the frons at the inside of the antennæ. The length in a straight line from the vertex to the farthest point of the abdomen is 4 mm., the total length from the upperlip to the pygidium measured along the back being about 10 mm. Allowing for further growth of the embryo and, on the other hand, for the telescoping of the segments when the embryo is born and straightened out, the length of the young larva, apart from the antennæ and callipers, may be estimated at from 10 to 12 mm.

This short survey of the morphology and anatomy of the adult *Arixenia jacobsoni* confirms our opinion that the insect stands apart from the other *Dermaptera*, the main distinctions being the great reduction of the eyes, the full number of abdominal segments in the female as well as in the male and larval stages, the primitive form of the callipers, the unique structure of the male genitalia, and ovarian pregnancy. To these characteristics may be added, as of secondary importance, the great hairiness of the whole exoskeleton (even exceeding that of the bristly *Echinosomatinae*), the relatively large size of the head, the complete fusion of the eleventh and twelfth abdominal segments (pygidium and metapygidium), the small size of the sternites

adjacent to the anus and callipers, the absence of ganapophyses in the ♀ and, instead, the large development of the eighth sternite in that sex and the presence of a special sclerite (the clutch) accessory to copulation, and the comparatively feeble development of the tenth tergite correlative with the weakness of the callipers.

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ÉTUDE MORPHOLOGIQUE SUR LA CONSTRUCTION DE L'ÉLYTRE DES CICADIDES.

Par G. HORVÁTH, BUDAPEST.

(Avec 2 figures.)

LES élytres des Cicadides sont construites sur un plan assez uniforme. Elles sont généralement membraneuses et hyalines, mais aussi parfois plus ou moins coriaces et colorées, au moins sur leur moitié basilaire. Leur forme est elliptique, arrondie à l'extrémité, rarement anguleuse. Elles couvrent le corps en toit et sont composées de deux pièces : une grande pièce externe allongée, qui comprend la plus grande partie de l'élytre, c'est la *corie* à laquelle vient se relier au moyen d'une suture mobile l'autre pièce étroite, triangulaire, le *clavus*.

Les nervures sont toujours bien distinctes et généralement peu nombreuses. C'est précisément la disposition et les relations de ces nervures qui font l'objet principal de ma présente communication.

Nous connaissons bien les remarquables travaux de COMSTOCK et NEEDHAM sur les ailes des Insectes,¹ où tout un chapitre est consacré aux ailes des Cicadides. J'ai fait mes recherches d'abord indépendamment de ces deux auteurs, et après avoir terminé mon étude, j'ai eu la grande satisfaction de pouvoir constater que, sauf les deux premières nervures longitudinales de l'élytre, je suis arrivé à peu près au même résultat.

COMSTOCK et NEEDHAM ont déjà fait remarquer avec raison que les Cicadides sont, parmi les Insectes, ceux qui ont le mieux conservé la disposition des nervures des organes du vol des types ancestraux.

I. NERVURES LONGITUDINALES.

Les nervures longitudinales des élytres répondent en effet fort bien au schéma que les deux auteurs américains ont signalé

¹ T. H. COMSTOCK and T. G. NEEDHAM, *The Wings of Insects*, Ithaca, U.S.A., 1898-9.

pour toute la classe des Insectes. Ils ont établi que les élytres et les ailes des Insectes possèdent à l'état normal 8 nervures longitudinales. Or, ces 8 nervures longitudinales qui répondent aux 8 branches des trachées parcourant les moignons élytraux chez les nymphes des Cicadides, se retrouvent aussi dans les élytres des adultes, avec la seule restriction que les deux premières nervures longitudinales y sont réunies et soudées dans tout leur parcours.

En allant du bord antérieur de l'élytre à son bord postérieur on trouve les nervures suivantes :

1. La *nervure costale* (fig. 7 c) qui prend naissance à la base et se continue à peu près jusqu'à l'extrémité de l'élytre sans se ramifier.

Tous les auteurs—aussi COMSTOCK et NEEDHAM—ont pensé jusqu'à présent que la nervure costale n'occupe que les deux tiers basilaires environ de l'élytre et qu'elle s'arrête brusquement déjà avant le tiers apical. Cette opinion, généralement admise mais erronée, s'explique par le fait que la nervure costale est interrompue dans son parcours par une fracture oblique et que, immédiatement derrière cette fracture, une nervure oblique aboutit à la nervure costale et s'anastomose avec elle ; cela donne en effet l'aspect comme si la partie apicale de la nervure costale était seulement la continuation de cette nervure oblique. Cependant nous verrons plus tard que la fracture oblique sur la nervure costale n'est que la continuation de la grande fracture transversale qui coupe toutes les nervures longitudinales du disque, et que la nervure oblique qui se joint à la nervure costale n'est qu'une partie de la nervure transversale intermédiaire.

En examinant l'élytre surtout à sa face inférieure, on peut constater que la nervure présente généralement dans toute sa longueur la même coloration et la même sculpture, en prouvant que sa partie distale n'est en effet que la continuation directe de la partie proximale.

2. La *nervure subcostale*, qui est encore parfaitement séparée de la nervure costale dans les moignons élytraux des nymphes, est entièrement soudée avec cette nervure dans les élytres des adultes. Elle contribue ainsi à renforcer la nervure costale, qui est par conséquent toujours la plus forte et la plus épaisse nervure de l'élytre.

La nervure subcostale a été totalement méconnue jusqu'à présent. La plupart des auteurs l'ignorait. COMSTOCK et NEEDHAM sont les premiers qui l'ont signalée chez les nymphes, sans reconnaître cependant ce qu'elle est devenue chez les adultes. Ils ont pensé qu'elle y est soudée d'abord avec la nervure radiale, puis s'en sépare pour se rapprocher du bord antérieur où elle se dirige vers le sommet de l'élytre. Ces auteurs ont donc pris la partie apicale de la nervure costale pour celle de la nervure subcostale, en supposant que la courte nervure oblique qui relie la nervure radiale et la nervure costale, et dont j'ai parlé tout à l'heure, est le tronc basal par lequel la nervure subcostale quitte la nervure radiale. Mais cette courte nervure oblique n'est en réalité qu'une partie de la nervure transversale intermédiaire qui s'étend, généralement oblitérée et disparue sur le disque, entre la pointe du clavus et le bord antérieur de l'élytre, et sur le compte de laquelle je reviendrai encore.

3. La *nervure radiale* (fig. 7 r) représente une seule nervure parallèle à la nervure costale et se divise vers le milieu de l'élytre en deux branches, dont l'antérieure se bifurque encore une fois et forme avec la partie apicale de la nervure costale la cellule postcostale.

On croyait autrefois, et les systématiciens de nos jours sont encore de cet avis, que la nervure radiale s'étend seulement jusqu'à la nervure transversale intermédiaire et que ses deux branches ainsi que la partie apicale de la nervure costale sont de ramifications de la nervure longitudinale suivante. Cependant il n'en est pas ainsi. Un examen plus attentif nous démontre que les deux branches en question ne sont en effet que la continuation de la nervure radiale. On le voit bien nettement chez les espèces où les nervures de l'élytre, qui se rencontrent et se croisent dans la région de la nervure transversale intermédiaire, sont encore moins rapprochées et moins soudées. On y remarque que la branche postérieure de la nervure radiale prend naissance en effet de la nervure radiale, en croisant bientôt la nervure transversale qui s'étend entre la nervure costale et la branche antérieure de la nervure longitudinale suivante, et que l'on avait attribuée également à cette dernière nervure. Cette explication est aussi confirmée par la disposition des branches trachéales dans les moignons élytraux des nymphes.

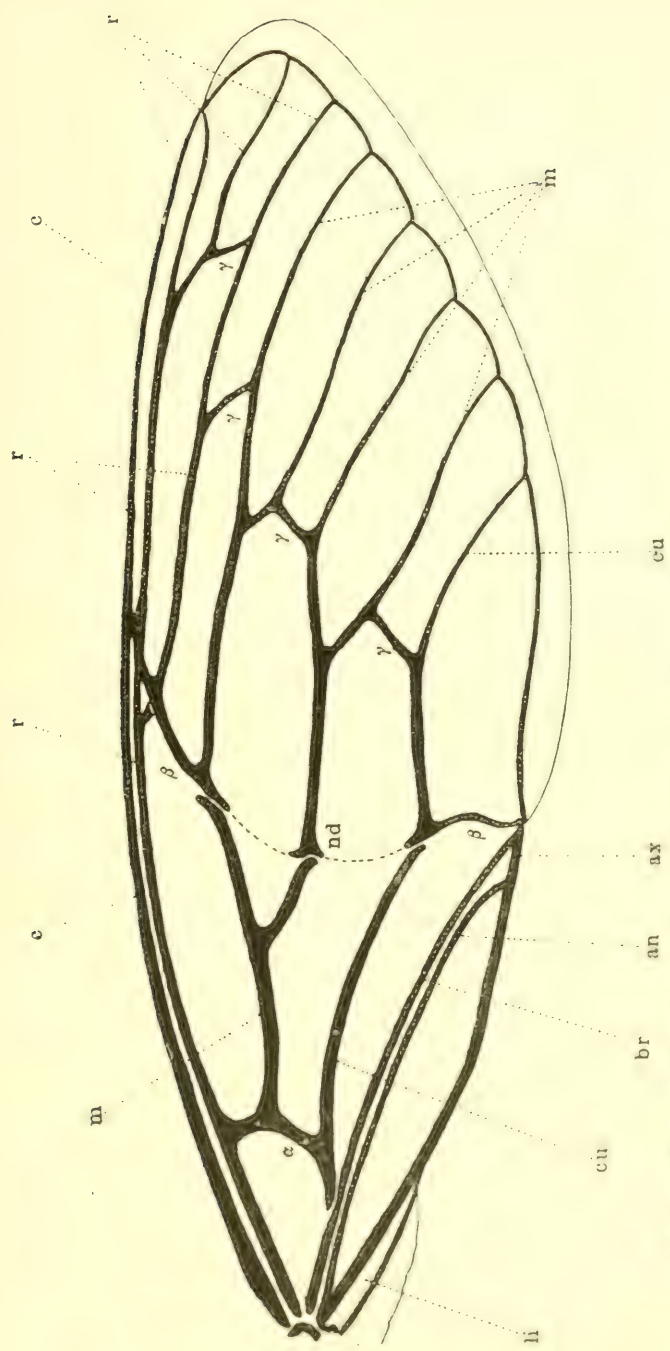


Fig. 1. — Élytre d'une *C. adulte*. c, nervure costale; r, n. radiale; m, n. médiane; cu, n. cubitale; br, n. brachiale; an, n. antérieur; ax, n. axillaire; nd, nodule axillaire; a, areolus; γ, nervures transversales. Intermédiaire; nervure antérieure des.

La disposition de ces nervures chez les adultes donne bien l'apparence que la branche antérieure de la nervure radiale et la partie apicale de la nervure costale sont les continuations de la nervure transversale susmentionnée ; mais cette apparence n'est que superficielle, elle est causée uniquement par la fracture oblique dont j'ai parlé déjà à propos de la nervure costale et qui coupe aussi la nervure radiale immédiatement après sa bifurcation. (Fig. 8.)

4. La quatrième nervure longitudinale est la *nervure médiane* (fig. 7 *m*), qui se divise généralement dès le premier tiers de l'élytre en deux branches, dont chacune se bifurque encore une fois.

5. La cinquième nervure longitudinale est la *nervure cubitale* (fig. 7 *cu*). Elle reste toujours simple et se dirige sans ramifications vers le bord apical de l'élytre. Dans certains genres (p. ex. *Melampsalta*) elle est, à la base, tellement rapprochée de la nervure médiane que les deux nervures s'y touchent ou se fondent même en une seule tige commune plus ou moins longue.

6. La sixième nervure longitudinale a échappé à la plupart des auteurs, car elle est généralement plus ou moins soudée avec la nervure suivante et ne se fait remarquer qu'à la base et au sommet. Dans les genres américains *Tettigades*, *Chonosia*, et *Babras* elle est séparée dans toute sa longueur et on peut bien voir qu'elle sort d'un point commun avec la nervure cubitale, mais dont elle se sépare bientôt et se continue tout droit sans ramification jusqu'à l'extrémité du clavus. COMSTOCK et NEEDHAM ont appelé cette nervure la première nervure anale ; mais comme elle appartient encore à la corie, il me paraît plus juste de la distinguer par un nom spécial, et de l'appeler *nervure brachiale* (fig. 7 *br*).

7-8. Les deux dernières nervures longitudinales de l'élytre se trouvent déjà sur le clavus. Elles ne jouent aucun rôle dans la classification des Cicadides et n'ont pas attiré l'attention des auteurs, qui les ont prises tout simplement pour une seule nervure entourant le clavus. On les retrouve aussi chez les autres Homoptères, où elles sont plus ou moins séparées. Leur séparation est complète dans la famille des Jassides. SAHLBERG a nommé la nervure plus rapprochée de la suture

du clavus *nervure anale* (fig. 1 an), et celle qui est plus près de la commissure du clavus, *nervure axillaire* (fig. 7 ax).

Dans les Cicadides, la nervure axillaire est un peu éloignée du bord postérieur de l'élytre et forme avec celui-ci une bordure étroite coriace que j'ai nommée *limbe axillaire* du clavus (fig. 7 li). La nervure axillaire paraît se rapprocher graduellement de la commissure, puis devenir et rester marginale jusqu'au sommet du clavus. Mais en réalité elle n'est pas marginale. Cette apparence est due seulement à ce que le bord postérieur de l'élytre (le limbe axillaire du clavus) y est enroulé en dessous et en dedans pour pouvoir s'accrocher au bord antérieur retroussé de l'aile postérieure. Par cette disposition l'élytre et l'aile sont rendues solidaires dans leurs mouvements.

La nervure axillaire se continue aussi sur la corie et y forme avec la continuation de la nervure costale la *nervure périphérique*, qui est parallèle au bord apical de l'élytre et relie à leur extrémité les dernières ramifications des nervures radiale, médiane, et cubitale. La nervure périphérique est généralement éloignée du bord apical, laissant une bordure libre dépourvue de nervures. Cette bordure devient dans certains groupes assez étroite et disparaît complètement dans une dizaine de genres (*Arcystasia*, *Thaumastopsaltria*, *Cystopsaltria*, *Arfaka*, *Lembeja*, *Prasia*, *Drepanopsaltria*, *Cystosoma*, *Hemidictya*, *Hovana*) ; la nervure périphérique devient ainsi marginale.

II. NERVURES TRANSVERSALES.

Les nervures transversales constituent trois groupes :

1. Le premier n'est représenté que par une seule nervure près de la base de l'élytre. C'est l'*arculus* (fig. 7 a) qui, partant de la nervure radiale et croisant la nervure médiane, s'étend jusqu'à la nervure cubitale et forme avec ces deux dernières nervures la cellule basale.

2. Le deuxième groupe comprend les *nervures transversales intermédiaires* (fig. 7 β), qui se trouvent dans la région comprise entre le deuxième tiers de la nervure costale et l'extrémité du clavus. Généralement il y en a deux, l'une qui relie la nervure costale avec la branche antérieure de la nervure médiane, l'autre qui est située entre la nervure cubitale et le sommet du

clavus. Cependant ces deux nervures ne sont que les restes d'une seule grande nervure transversale qui s'est étendue autrefois au travers de toute la corie, mais dont la partie discoidale, c'est-à-dire celle qui est située entre la branche antérieure de la nervure médiane et la nervure cubitale, est disparue et n'existe plus. Les traces de cette nervure, atrophiée en partie, sont presque toujours reconnaissables chez toutes les Cicadides.

En examinant un peu plus attentivement leurs élytres, on remarquera le long de la branche postérieure de la nervure médiane un petit nodule (fig. 7 *nd*) qui ne manque que très-rarement. Ce nodule a échappé jusqu'à présent aux auteurs qui se sont occupés de Cicadides, mais il a été très-bien remarqué par tous les bons artistes qui ont dessiné ces Insectes. Il suffira de citer les planches publiées dans la Monographie des Cicadides Orientales de notre honoré collègue DISTANT.¹ Le nodule y est fidèlement reproduit dans chaque figure. Or, si on inspecte obliquement, sous une certaine lumière, l'élytre de n'importe quelle Cicadide, on découvrira sur le disque, même dans les élytres tout à fait hyalines et transparentes, un pli courbé qui part du nodule susmentionné vers l'avant jusqu'à la branche antérieure de la nervure médiane et en arrière jusqu'à la nervure cubitale, et relie ainsi les deux nervures transversales intermédiaires. Le nodule discoidal nous permettra toujours de retrouver les traces du pli transversal.

Le pli transversal, signalé déjà par HAGEN ("feine Linie"), DISTANT ("elevated line across the middle"), et JACOBI ("bogige Deckflügelfalte"), est plus facile à reconnaître chez les espèces dont les élytres sont en partie coriaces ou colorées, et chez lesquelles il est indiqué par un trait obscur. Ce trait est remplacé souvent par une nervure plus ou moins forte, rappelant ainsi de plus en plus l'état ancestral où la grande nervure transversale intermédiaire de l'élytre n'était pas encore atrophiée au milieu, mais entière. Ainsi le genre *Tettigarcta*, beaucoup de *Platypleura*, etc., offrent une seule nervure transversale intermédiaire bien développée et complète.²

¹ W. L. DISTANT, *Monograph of Oriental Cicadidæ*, London, 1889-92.

² On trouve accidentellement aussi chez les espèces dont les élytres possèdent normalement une nervure transversale intermédiaire incomplète, des cas d'atavisme où certaines parties oblitérées et disparues de

3. Le troisième groupe des nervures transversales est situé dans la moitié apicale de l'élytre. Ces nervures, appelées *nervures antecapicales* (fig. 7 γ), qui sont généralement au nombre de quatre, relient les ramifications apicales des nervures longitudinales et ferment à leur base les 2^e, 3^e, 5^e, et 7^e cellules apicales.

Les élytres avec la disposition des nervures telle que je viens de la décrire, représentent le type normal généralement répandu dans la famille des Cicadides. On trouve cependant aussi quelques modifications plus ou moins accentuées de ce type. Les modifications sont limitées aux nervures de la corie et se manifestent dans une réduction ou dans une multiplication des ramifications, mais le nombre des nervures longitudinales reste toujours le même.

La réduction des ramifications du type normal est très-rare et ne se trouve que dans trois genres. Dans le genre *Oligoglena* la branche antérieure de la nervure médiane n'est pas ramifiée et atteint la nervure périphérique sans se bifurquer. Il en résulte que le nombre des cellules apicales est de sept au lieu de huit. Le genre *Triglana* a aussi une pareille disposition des nervures et par conséquent sept cellules apicales. La réduction des dernières ramifications la plus avancée se remarque dans les deux genres *Derotettix* et *Tettigomyia*, dont les élytres n'ont que six cellules apicales.

L'augmentation du nombre des ramifications est relativement un peu moins rare. Elle apparaît d'abord sous une telle forme que la branche postérieure de la nervure médiane offre des ramifications plus nombreuses et que le nombre des cellules apicales qui conservent leur forme allongée à côtés à peu près parallèles, monte à 9 et davantage, jusqu'à 14 ou 15. Telle est la disposition des nervures dans une demi-douzaine de genres (*Chlorocysta*, *Venustria*, *Graptotettix*, *Paravittya*, *Mardalana*, *Thaumastopsaltria*). La multiplication des ramifications se borne ici à la branche postérieure de la nervure médiane tandis que cette nervure réapparaissent de nouveau. J'ai sous les yeux, par exemple, un mâle de *Mogannia hebes* Walk. chez lequel la nervure transversale intermédiaire, en reliant la nervure cubitale et la branche postérieure de la nervure médiane, se continue vers l'avant—sur toutes les deux élytres—jusqu'à la branche antérieure de celle-ci. Un mâle de *Melampsalta musiva* Germ. présente le même cas d'atavisme sur l'élytre gauche.

la branche antérieure reste simplement bifurquée comme dans le type normal. Cependant dans le genre oriental *Angamiana* même la branche antérieure ne demeure plus intacte, mais se divise en trois rameaux au lieu de deux. La ramification est encore plus abondante et atteint le plus haut degré dans le genre oriental *Polyneura*, où la nervure médiane commence à se ramifier déjà depuis la cellule basilaire et les ramifications de ses deux branches vont se dissoudre dans la moitié apicale de l'élytre en une vingtaine de ramules parallèles reliées entre

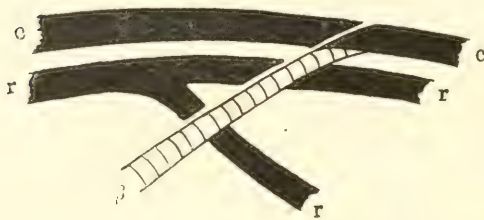


FIG. 8.—La nervure transversale intermédiaire (β) près du bord antérieur de l'élytre. c, nervure costale ; r, nervure radiale.

elles par de petites ramuscules transversales. Les ramifications de la branche postérieure de la nervure médiane sont aussi dans ce cas beaucoup plus nombreuses que celle de la branche antérieure.

Dans un autre groupe comprenant les genres *Cystosoma*, *Talainga*, *Arcystasia*, *Hemidictya*, et *Hovana*, la moitié apicale de l'élytre offre un réseau de cellules hexagonales plus ou moins irrégulières.

Comme je l'ai dit tout à l'heure, dans tous ces cas aberrants, les autres nervures longitudinales de l'élytre ne prennent pas part à la ramification plus abondante de la nervure médiane et ne s'éloignent pas du type normal. Aussi la nervure transversale intermédiaire n'en est point altérée, et, complète ou incomplète, elle garde toujours sa position et sa direction originelles.

Avant de terminer je ne puis passer sous silence la grande fracture transversale qui traverse le disque de l'élytre le long des nervures transversales intermédiaires et y coupe toutes les nervures longitudinales sans être altérée par leur disposition.

Un examen un peu plus attentif de cette région de l'élytre nous permettra de reconnaître bien facilement que le petit nodule discoidal qui se trouve sur la branche postérieure de la nervure médiane et dont j'ai déjà parlé (fig. 7 *nd*), est toujours divisé en deux parties par une fine fracture transversale. Cette

fracture ne manque jamais, elle est visible aussi dans les rares cas où la nervure grêle et simple n'y est nullement épaissie. En continuant nos recherches, nous retrouverons la même fracture plus ou moins distinctement indiquée au bord proximal de la nervure transversale intermédiaire qui relie la branche antérieure de la nervure médiane avec la nervure radiale et la nervure costale, et surtout aux endroits où ces nervures se croisent. On peut la suivre jusqu'au bord antérieur de l'élytre où elle finit après avoir coupé les deux branches de la nervure radiale (fig. 8). La nervure cubitale et la nervure axillaire présentent les mêmes dispositions. Cette dernière nervure est coupée par la fracture immédiatement après le sommet du clavus. Les nervures longitudinales ont, partout où la fracture les traverse, l'apparence d'être fracturées et recollées ensuite artificiellement. Dans les cas où la nervure transversale intermédiaire est complète (p. ex. *Polyneura*, *Cystosoma*), la fracture est aussi bien visible, au côté proximal de la nervure, depuis le bord antérieur jusqu'au bord postérieur de l'élytre.

Il est évident que cette fracture transversale, mentionnée déjà par REDTENBACHER,¹ est identique au "sillon nodal" (nodal furrow) que COMSTOCK et NEEDHAM ont constaté sur les ailes de plusieurs ordres des Insectes; elle est incontestablement identique à la suture qui divise l'élytre des Hétéroptères en deux parties, la corie et la membrane. Une pareille disposition ne se retrouve dans aucune autre famille des Homoptères. Certains genres de Fulgorides offrent bien dans la moitié apicale des élytres une nervure transversale intermédiaire qui s'étend entre le bord antérieur de l'élytre et le sommet du clavus, et derrière laquelle la partie apicale de l'élytre est pourvue de cellules plus nombreuses, mais une fracture transversale qui couperait les nervures longitudinales, n'y existe pas.

Cette fracture transversale, telle que je viens de la décrire, est propre, parmi tous les Homoptères, exclusivement à la famille des Cicadides. On pourrait dire que grâce à cette disposition leurs élytres ne sont pas de vraies homélytres, mais plutôt des hémélytres, et que par conséquent les différences

¹ JOSEF REDTENBACHER, "Vergleichende Studien über das Flügelgeäder der Insekten" (*Annalen des K.K. naturhistorischen Hofmuseums*, i., 1886, p. 186).

morphologiques entre les deux sous-ordres des Hémiptères, les Homoptères et les Hétéroptères, se diminuent ainsi encore d'un caractère de plus. Comme on connaît d'un côté certaines familles d'Hétéroptères (Véliides, Gerrides, Hydrométrides, Hénicocephalides, etc.) qui ont de vraies homélytres, nous voyons maintenant qu'il existe aussi de l'autre côté une famille d'Homoptères dont les élytres offrent tous les caractères de véritables hémélytres, divisées en clavus, corie, et membrane.

DIE DIFFERENZIERUNG DER ZOOGEOGRAPHISCHEN ELEMENTE DER KONTINENTE.

Von HERMANN J. KOLBE, BERLIN.

Das formenreiche Tierleben der Kontinente und Inseln, welches seit langer Zeit viele Naturforscher in verschiedenem Grade beschäftigt hat und noch lange beschäftigen wird, ist oft vom Standpunkte der wissenschaftlichen Ordnung aus im grossen Style bald systematisch, bald auf der Grundlage der Systematik zoogeographisch geordnet worden. Wir heben besonders das WALLACE'SCHE Werk über die Verbreitung der Tiere, welches seit einigen Jahrzehnten mit grösseren oder geringeren Abänderungen die Grundlage für zoogeographische Forschungen ist, hervor. Die zoogeographischen Provinzen festzustellen, ist das stete Bestreben der Zoogeographen gewesen. Aber die zoogeographischen Provinzen sind meistens nicht deutlich voneinander getrennt. Überall sind Übergänge zu erkennen, ein Ineinandergreifen von Gattungen und Arten der einander benachbarten Provinzen. Das führte niemals zu festen Vorstellungen. Selbst trennende Meere lassen zuweilen bald erkennen, dass die Tiergruppen der beiderseitigen Länder zusammengehören. Diese Qualität der zoogeographischen Provinzen hat also nur geringen Wert. Es ist besser, den zoogeographischen Inhalt der Kontinente zu analysieren. Eine solche Analysierung sollte keinesfalls eine ungefähre Schätzung sein; sie ist nur zu erreichen auf der Grundlage eines natürlichen Systems. Das System ist das Resultat der vergleichenden Morphologie. Durch vergleichende Morphologie unterscheiden wir unentwickelte und entwickelte Formen, primäre und abgeleitete Gruppentypen, elementar und kompliziert organisierte Gattungen.

Es existieren auf manchen Kontinenten noch isolierte Familientypen von Coleopteren von absonderlicher Organisa-

tion. Sie sehen fremdartig aus in der Umgebung der vielen rezenten Gattungen; sie sind die letzten Zeugen einer grösseren Vergangenheit ihrer Familie. Die Familie, welcher solche Gattungen angehören, muss früher formenreicher gewesen sein, als in der Jetztzeit. Solche Formen gehören einem altzeitlichen Element an; sie bilden ein absonderliches Element in der biogeographischen Provinz.

Gehört eine Gattung zu einer Gruppe von Familien, welche die Kontinente rings um den Nordpol bewohnen, so sehen wir in dieser Gattung eine Angehörige des holarktischen Elements des betreffenden Kontinents. Die holarktische Natur ist das Resultat der geologischen Vorgänge und der Verbreitung innerhalb einer gewissen Zeitperiode.

Wir werden auf diese Weise den historischen Inhalt des zoogeographischen Areals eines Kontinents kennen lernen. Wir werden gewisse, aus einer alten geologischen Periode stammende Gattungen, z. B. *Amphizoa*, die noch in die Gegenwart hineinragen, als lebende archaische Formen, gewissermassen als "lebende Fossilien" (*sit venia verbo*) erkennen und von den neuzeitlichen Formen unterscheiden. Wir werden gewisse Gattungen als direkte Nachkommen mesozoischer Formen erkennen und dementsprechend als mesozoisches Element behandeln. Auch die Frage der Relikte tritt in ein neues Stadium. Relikte aus der Glazialzeit gehören zu dem glazialzeitlichen Element der Fauna eines Landes.

Wenn wir fernabliegende Kontinente auf ihren biogeographischen Inhalt prüfen, so finden wir oft eine Harmonie mit dem biogeographischen Inhalt der uns näher liegenden Kontinente heraus. Wir müssen hier mit dem Factor rechnen, dass die nördlichen Kontinente und die Südkontinente schon in frühen geologischen Perioden selbständige Faunenbezirke waren. Die nördlichen und südlichen Kontinente waren teils durch Meere, teils durch Wüsten voneinander getrennt. Aber eine ursprüngliche frühzeitige Verbindung der nördlichen und südlichen Kontinente war eine Zeitlang vorhanden; sie vereinigte Ostasien über Hinter-Indien und Indonesien mit Australien. Ueber diesen Kontinent konnten Tiere Nordasiens sich bis Australien verbreiten. Wenn dazu die Verbindung Australiens mit dem antarktischen Gebiet kommt, war sogar eine Ver-

breitung europäischer Tiere, über Asien und Australien bis Südamerika möglich. Vielleicht ist hierdurch manche Verwandtschaft zwischen Chile und Europa zu erklären. Natürlich wurden auf diesem langen Wege viele Formen differenziert; viele scheinen den Ahnen auf der Nordhemisphäre ähnlich geblieben zu sein. Aber die Entstehung vieler neuer besonderer Gattungen auf der Südhemisphäre dürfte wohl durch das Vorhandensein derselben auf den Südkontinenten erwiesen sein. Das antarktische Element spielt auf den südlichen Kontinenten eine sehr grosse Rolle. Es handelt sich gewöhnlich darum, die Beziehungen mancher Gattungen eines Kontinents zu den Gattungen anderer Kontinente, herauszufinden, um die Natur der Elemente, zu denen diese Gattungen gehören, festzustellen. Geologie und Klimatologie sind hierbei wertvolle Hilfswissenschaften, um die biogeographischen Elemente zu erkennen. Auch die Feststellung der Beziehungen der Inselfaunen zu den Faunen der Kontinente fördert die Erkenntniss. Der tiefer liegende Wert der Wissenschaft besteht eben darin, die Beziehungen der Dinge aufzudecken. Tatsachen, die hiezu auffordern, sind zahlreich. Das Gebiet der Beziehungen der Tierformen zueinander und zu ihren Wohnplätzen, ihrem Kontinent, ihrer Insel, ist sehr umfangreich. Die Fragen der Ausbreitung der Tiere über die Erde von gewissen Zentren der Kontinente aus gehören zu den Problemen der Gegenwart. Mir wird es immer wahrscheinlicher, dass der Hauptstrom der Tierwelt der Osthemisphaere schon in den ältesten Perioden des mesozoischen Zeitalters von Nordasien und Ostasien über eine breite australasiatische Brücke nach Neuholland gezogen ist, und dass der Entwicklungsherd Australien grosse Züge von Gattungen und Gruppen der Tier- und Pflanzenwelt über den Südpolarkontinent nach Archiplata und Südamerika abgegeben hat. Europa erscheint mir nur als zoogeographisches Anhängsel Asiens. Hochasien ist ein uraltes Massiv mit reichhaltigen Evolutionselementen, die sich grossartig entfalten. Auch das alte borealeuropäische Massiv hat daran etwas teilgenommen. Wir hoffen, diese Punkte an einer Betrachtung der Coleopterenfauna Asiens und Europas klarzulegen.

ASIEN.

Das mächtige Massiv Asiens, welches eine ausserordentlich grosse Entwicklung in die Breite hat und sich einerseits bis in die arktische, andererseits bis in die tropische Zone erstreckt, weist vor Allem im Innern, wo die hochgelegenen Plateaux von mächtigen Randgebirgen begrenzt werden, und ebenso in den Abdachungen des Westens wie des Ostens ein sehr reichhaltiges, besonders an indigenen Gattungen reiches Element der verschiedenartigsten Tierformen auf. Hier ist das umfangreiche Verbreitungszentrum zahlreicher Familien, Gruppen, und Gattungen, welches eine Fülle von Tiergruppen sowohl nach Europa als auch in das arktische Gebiet, dann nach Südwestasien, auch nach dem Süden und Osten, besonders nach Nordamerika abgegeben, wo auf ausgedehntem uralten Boden ein neues Verbreitungszentrum für Amerika entstand. Frühzeitig wanderten die Angehörigen vieler Gruppen und zahlreicher Gattungen von dem asiatischen Verbreitungszentrum aus, über Ostasien südwärts nach Australien, das während der Jurazeit über die Philippinen und Hinterindien hinweg mit Ostasien verbunden war. Auf diese Weise wurde weit und breit die Erde mit Tieren der verschiedensten Gattungen bevölkert und zahlreiche Gattungen über mehrere Kontinente verbreitet. Doch entsprachen die damaligen Kontinente noch nicht den gegenwärtigen. Manche Teile von Kontinenten waren noch mit Meeren bedeckt, andere Teile von Kontinenten waren zusammenhängendes Festland dort, wo jetzt grosse Inseln sind.

Asien ist in seiner Hauptmasse ein uralter Kontinent. Vom Kaspischen Meere bis Ostchina ist Asien, nach NEUMAYR, ein sehr altes, aus archaischen und paläozoischen Erdschichten bestehendes Festland. Auf diesem alten grossen Kontinent befinden sich weit ausgedehnte uralte *Reservate* einer sehr differenzierten Tierwelt. Central-Asien, Hochasien, besonders Tibet, auch Turkestan sind die Landgebiete im Innern des Kontinents, welche diese Reservate enthalten. Hier est eine urzeitliche Tierwelt vorhanden, um mit MATSCHIE's Worten zu reden; hier blieben viele Gattungen vom Untergange verschont, dem sie in angrenzenden Ländern erlegen sind. Von *Mammalien*

dieses Urgebietes sind zu nennen: 3 Maulwurfarten (Talpiden) in der Mongolei und Tibet; Gattungen aller 4 Gruppen der Spitzmäuse in Central-Asien, nämlich Crossopodinen, Soricinen, Crocidurinen, Blarinen (sonst nirgendwo so viel, ausser in Nordamerika); Arten von Moschusspitzmäusen (Myogaliden) in Tibet, andere Arten in den zum Kaspischen und Aralsee abwässernden Gegenden; verschiedenartigste Bären (*Ursus*) in Tibet, eigentümliche Arten der schwarzen und der braunen Bären, ausserdem ein blaugrauer Bär, dann der schwarzweisse Bambusbär (*Ailuropus*); ferner der Pandabär (*Ailurus*) im östlichen Tibet und Himalaya; der merkwürdige Viverrenhund oder Tanuki (*Nyctereutes*) in Tibet, China und Japan; die verschiedenartigsten Feliden in Central-Asien, besonders der Tiger (*Uncia*), Leopard (*Leopardus*), Wildkatze (*Catus*), Luchs (*Lynx*), Tigerkatze (*Felis*), wozu in Tibet noch der Irbis, der Nebelpanther, die Marmelkatze, die Zwergkatze und die langschwänzige Rotkatze treten (eine Mannigfaltigkeit, wie in keinem andere Lande); dann Wühlratten (*Myotalpa*) in Mittel- und Ostasien; die Wurzelratten (Spalaciden) in Central-Asien bis Japan, auch in Südasien und Südosteuroopa; die Streifenmäuse (Sminthinen), die Pfeifhasen (*Lagomys*), die Wildschafe (*Ovis*), die Pferde (*Equus*), die Edelhirsche (*Cervus*) der Wapitigruppe, die Moschustiere (*Moschus*), verschiedene Antilopen in der Mongolei und Tibet, die merkwürdige Stierantilope (*Budorcas*) in Tibet und der Yak (*Pocphagus*) in Tibet.

Diese Beispiele aus dem Reiche der Vertebraten mögen genügen, um die grosse Mannigfaltigkeit der Tierwelt Central-Asiens und besonders den insularen Reichtum Tibets an absonderlichen, relikttären Formen zu beleuchten.

Das formenreiche indigene Element Central-Asiens.

Wahrscheinlich muss Central-Asien als der immense *Entstehungsherd* der paläarktischen Tierwelt betrachtet werden. Die rezente Tierwelt dieses Urgebietes gehört grossenteils zu einem alten formenreichen indigenen Element, welches von Alters her noch konserviert worden ist.

Die Zahl der endemischen Coleopterengattungen Central-Asiens ist recht gross; deshalb ist es unthunlich, sie an diesem

Orte alle aufzuzählen. Es seien z. B. nur mehrere *Tenebrioniden*-gattungen erwähnt: von der Gruppe der Platyopinen *Apatopsis* und *Habrochiton* (Chinesisch-Turkestan), *Habrobates* (Transkaspien), *Przewalskia* (Tibet), *Earophanta* (Turkestan, Transkaspien), *Homopsis* (Songarei), und *Mantichorula* (Chinesisch-Turkestan, Mongolei, China); von der Gruppe der Erodiinen *Diaphanides* (Turkestan, Transkaspien), *Ammozoum* (Buchara, Transkaspien), und *Arthrodoxis* (Buchara, Transkaspien, Turkmenien); von der Gruppe der Lachnogyinen *Lachnogya* (Turkestan, Afghanistan) und *Netuschilia* (Buchara); von der Gruppe der Leptodinen 3 Gattungen mit 18 Arten in Chinesisch-Turkestan, China, Nordpersien, Turkestan, und Transkaspien; auch von der Gruppe der Pimeliinen noch eine Reihe Gattungen, ebenso noch von anderen Gruppen der Tenebrioniden manche Gattungen.

Zahlreich sind die endemischen Subgenera von *Carabus*, welche auf Central-Asien beschränkt sind, nämlich *Cephalornis*, *Cathaicus*, *Cathaicodes*, *Acathaicus*, *Cratocephalus*, *Pachycechenus*, *Cratocarabus*, *Pseudotribax*, *Cratophyrtus*, *Pantophyrtus*, *Cratocechenus*, *Calocechenus*, *Alipaster*, *Alogocarabus*, *Calocarabus*, *Iamaibius*, *Pseudocranion*, *Axinocarabus*, *Cychrostomus*, *Paraplesius*, *Deroplectes*, *Goniognathus*, *Pagocarabus*, *Neoplesius*, *Cyclocarabus*, *Rhigocarabus*, *Aræocarabus*, *Ancylocarabus*, *Ophiocarabus*, *Cryptocarabus*, *Semnocarabus*, *Zoocarabus* (auch in Südwesteuropa), *Mimocarabus*, *Ulocarabus*, *Meganebrius*.

Die interessante Broscinengattung *Craspedonotus*, welche von A. V. SEMENOW recht übersichtlich bearbeitet worden ist, enthält 3 Spezies, von denen *Cr. tibialis* Japan, Korea, die Mandschurei und Ost-China, *Cr. himalayanus* den centralen Himalaya und *Cr. margelanicus* Turkestan bewohnt. Die nahe verwandte Gattung *Chætobroschus* findet sich in Kaschmir. Auch die nahe stehende Gattung *Broschus* bewohnt Asien in mehreren Arten, auch Central-Asien.

Die merkwürdige Staphylinidengattung *Physetops* ist mit 2 Arten auf Mittel-Asien beschränkt (Nord-Afghanistan, Beludschistan, Nord- und Ostpersien, Transkaukasien). Die grösste Form (*Ph. giganteus herculeanus* Sem.) ist 30–34 mm. lang.

Mesozoisches Element Central-Asiens.

Sehr altertümlich sind einige monotypische Familien Central-Asiens, die aber in einem bestimmteren Lichte erscheinen, als manche andere Gattungen.

Die *Amphizoiden*, ein sehr eigenartiger monotypischer Zweig der Adephagen, der eine sehr tiefe systematische und archaistische Position in dieser Familiengruppe einnimmt, da er ein Relikt der Uebergangsstufe zwischen den Carabiden und Dytisciden ist, diese Familie mit der einzigen Gattung *Amphizoa* ist auf Californien und benachbarte Gegenden (3 Spezies) and Ost-Tibet (1 Spezies) beschränkt, also wiederum in zwei Gegenden, welche überhaupt die Sitze altertümlicher oder monotypischer Formen sind. Characteristisch ist bei *Amphizoa* die Beschaffenheit der coxae posticae. Deren Form erinnert zwar an die Dytisciden, doch sind sie viel kleiner, also bei weitem nicht so ausgedehnt wie in dieser Familie; doch reichen sie gleichfalls bis an den Rand des Körpers und stossen innen aneinander, so dass das Metasternum hinten abgestutzt und von dem Abdomen vollständig getrennt ist. Bei den Carabiden reichen die coxae posticae (mit geringen Ausnahmen) nicht bis an den Rand des Körpers und berühren sich innen nicht, und das Metasternum ist zwischen den Coxen nach hinten zu verlängert und reicht bis an das Abdomen. Die Beine von *Amphizoa* sind nicht zum Schwimmen eingerichtet; dennoch wohnt der Käfer nebst der Larve im Wasser, und zwar in kalten fliessenden Gewässern, wo sie an Steinen und Holz sitzen, ohne zu schwimmen. HUBBARD und SCHWARZ haben die Larve von *Amphizoa insolens* Lec. in Utah entdeckt (*Proceed. Ent. Soc. Washington*, ii., 1892, p. 341). Die Larve hat Charaktere von den Carabiden (Mundteile) und den Dytisciden (Stigmen, Abdomen) und ist den *Carabus*-Larven ähnlich. Noch ein primitiver Charakter zeichnet diese Familie aus, nämlich der ungegliederte lobus exterior der Maxillen, der bei den Carabiden und Dytisciden zweigliedrig ist. Ich halte *Amphizoa* für ein *altmesozoisches Element*. Dasselbe gilt auch von *Pelobius* (von neueren Systematikern *Hygrobia* genannt), eine Adephagen-gattung, die gleichfalls eine tiefe phylogenetische Stellung bei den Dytisciden einnimmt und eine monotypische Familie

(Pelobiiden) bildet. Interessant ist auch bei den Arten dieser Gattung die geographische Verbreitung. Von den 4 bekannten Arten bewohnt eine Tibet, eine zweite Art ist nach Mittel- und Südeuropa abgegeben und 2 Arten nach Neuholland. Da Neuholland schon seit dem mesozoischen Zeitalter von Asien getrennt ist (während der Jurazeit war dieser Kontinent mit Südostasien noch verbunden), so existiert *Pelobius* schon seit dieser alten Zeit und ist augenscheinlich ebenfalls ein echtes mesozoisches Element. Die Pelobiiden weisen nahe Beziehungen zu der primitiven Organisation der Amphizoiden auf. Die *coxae posticae* sind sehr ähnlich gebildet. Aber der *lobus exterior* ist zweigliedrig. Die Beine sind jedoch Schwimmbeine. Hierdurch und durch den Körperbau steht *Pelobius* den Dytisciden näher. Die Antennen sind unbehaart wie bei den Amphizoiden und Dytisciden. Diese alten relikitären Familientypen haben noch bis in die Jetztzeit ein diskontinuierliches Dasein gefristet. Beachtenswert ist auch die Verbreitung der oligotypischen Gattung *Opisthius* (Carabidæ), von der eine Art in Nord-Indien, eine in Nordamerika lebt. Diese Gattung ist ebenfalls als uraltes Relikt anzusprechen. Alle diese altertümlichen Gattungen gehören ohne Zweifel zu dem alten mesozoischen Element, welches uns noch mehr beschäftigen wird. Die Verbreitung der Gattungen dieses Elements ist, weil sie als primäre Typen und uralte Formen anzusehen sind, in die mesozoische Zeit zu suchen. Und während dieser Zeit kommt für die Verbreitung jener Gattungen nur die Kreideperiode in Betracht. Während der Trias- und Juraperiode war Ostsibirien und das nordwestliche Teil Nordamerikas vom Meere überflutet, aber während der mittleren Epoche der darauf folgenden Kreideperiode war ganz Ostasien bis zur Behringstrasse kontinental, und ebenso Alaska mit Nordostasien kontinental verbunden. Also lagen die Verbreitungswege für terrestrische Tiere von Asien nach Nordamerika und umgekehrt während der mittleren Kreidezeit offen.

Noch viele andere Gattungen, die entweder altertümlichen Familien angehören oder besondere Formen isolierter Gruppen sind, verbreiteten sich über diese nordatlantische Kontinentalbrücke während der Kreideperiode; z. B. gewisse kleine oligotypische Familien, nämlich die Aegialitiden, Cephalaoniden, Othniiden.

Die artenarme Familie der *Aegialitiden* mit der einzigen

Gattung *Aegialites* ist in 2 Arten in Nordamerika (Sitkha, Californien), in 1 Art in Ostasien (Robben-Insel bei Sachalin) und in 1 Art in Persien vertreten. Die *Cephalooniden* (mit der einzigen Gattung *Cephaloon*) bewohnen in wenigen Arten die nördlichen Teile der atlantischen Landschaften Nordamerikas und Nordostsibirien. Etwas artenreicher sind die *Othniiden* mit der Gattung *Othnius*, deren Arten Nordamerika (von Californien bis Virginien, Mexico, und Central-Amerika), Asien (Japan, Batjan, Borneo, Ceylon), und das tropische Afrika bewohnen. Eine zweite Gattung, *Ababa*, ist in bezeichnender Weise noch in Nordamerika (Texas) entdeckt. Die in Nordamerika und Mexico artenreiche endemische Gattung *Pasimachus* (Fam. Carabiden) hat in Hinter-Indien eine nahe Verwandte, die prachtvolle Gattung *Mouhotia*. Die Cerambycidengattung *Callipogon* (sehr grosse Arten mit langen Mandibeln im männlichen Geschlecht), welche über Mexico, Central-Amerika und die Cordilleren-Landschaften Columbien bis Peru verbreitet, fand eingehende Beachtung, als in der Mandschurei vor einigen Jahren eine nahe Verwandte entdeckt wurde, ebenfalls eine sehr grosse Art, welche von der amerikanischen Gattung etwas differiert und deswegen von A. v. SEMENOW als Subgenus *Eoxenus* aufgestellt wurde.

Wahrscheinlich weisen diese morphologischen Differenzierungen auf ein hohes geologisches Alter hin. Das dürfte auch aus der Verbreitung der Parastasiinen hervorgehen. Diese alte Scarabaeidengruppe bewohnt sonst nur Süd- und Ostasien, Indo-Australien, und die Seychellen. Aber mit einem Gattungstypus sind die Parastasiinen auch im westlichen Nordamerika vertreten. Est ist die Gattung *Polymæchus*, die schon LECONTE und GEORGE HORN als nahe Verwandte dieser Gruppe bezeichnen, die sich aber nach OHAUS von *Parastasia* nicht unterscheiden lässt. *Parastasia Ferrieri* Nonfr. der Liu-Kiu-Inseln, der nördlichsten Art Ostasiens, ist (wie mir Herr Dr. OHAUS freundlichst mitteilt) die nächste Verwandte der *Polymæchus*-Art Kaliforniens. *Parastasia* gehört jedenfalls zu einem älteren mesozoischen Element, welches sich über eine *Kontinentalbrücke des Nord-Pacific* nach dem westlichen Nordamerika verbreitete. Auch 2 Glaphyrinengattungen Ostasiens, *Anthypna* und *Toxocerus*, letztere auch in Tonkin, schliessen sich hier an.

Parandra, eine primitive Cerambycidengattung, bewohnt nur in einer einzigen Art den Doppel-Kontinent Eurasien: *P. caspica* in Transkaspien, Nord-Persien, Turkomanien. In Amerika ist die Gattung vom Nordkontinent bis in den Südkontinent verbreitet (mehrere Arten). Dann finden sich einige Arten im australischen Gebiet, auch im tropischen Afrika. Die australischen Arten stammen wohl sicher aus dem mesozoischen Zeitalter von einer nordischen Zuwanderung. Aus Süd- und Ostasien scheint diese Gattung seitdem verschwunden zu sein.

Tertiärzeitliches Element Asiens.

Gewisse andere Gattungen sind ebenfalls über Nordamerika und Asien, meistens Ostasien verbreitet. Sofern sie keine isolierte Gattungstypen sind, dürften sie als tertiärzeitliches Element betrachtet werden. Dahin gehören z. B. manche Lamellicornier: *Oniticellus*, *Lachnosterna*, *Phileurus*-artige Gattungen; aber auch viele Gattungen der meisten Familien der Coleopteren sind sicher während der Tertiärzeit über die Kontinente der Nordhemisphäre verbreitet gewesen. Etwas absonderlich ist das zoogeographische Verhalten der Gattung *Ergates*. Unser *Ergates faber* L. soll aus dem Orient (Syrien) stammen und sich von dort aus über Süd- und Mitteleuropa und bis Algerien verbreitet haben. Noch einige andere Arten derselben Gattung sind aus Südwestasien bekannt. Der nahe verwandte *Ergates spiculatus* Lec. ist von Vancouver Island bis Nord- und West-Mexico verbreitet. Die Gattung mag früher auch in Ost- und Central-Asien existiert haben. Die verwandte Gattung *Prionus* hat sich in Asien besser konserviert; sie ist in einer grösseren Anzahl von Arten über Nord-, Mittel-, Ost- und Westasien, Europa und Nordamerika bis Mexiko verbreitet. Es ist interessant zu sehen, dass *Prionus* einer ostasiatisch-nordamerikanischen Kontinentalgemeinschaft entstammt. Die primitivste Art Nordamerikas, *P. laticollis*, ist nach LAMEERE die hier am nördlichsten wohnende; sie ist am nächsten verwandt mit der primitivsten Art Asiens, *P. Gahani*, welche im nordwestlichen China wohnt. Die am meisten modifizierten Arten (*palparis*, *integer*, *emarginatus*) sind in zentralen Regionen lokalisiert (Nebraska, Nord-Mexiko). Dies-

bezügliche Beispiele sind noch zahlreicher, aber sie können hier nicht alle aufgezählt werden. Nur *Phellopsis* möchte ich noch erwähnen, eine eigentümliche Tenebrionidengattung, die zur Gruppe der Zopherinen gehört, welche in Nordamerika am formenreichsten differenziert ist und hier aus mehreren Gattungen besteht; sie sind hier nordwärts bis Canada und Neu-England verbreitet. Die Gattung *Phellopsis* bewohnt in mehreren Arten Nordamerika (Californien, Oregon, Idaho, Pennsylvanien) und Ostasien (Amur, China, Japan). Es ist einleuchtend, dass sich die Gattung über eine nördliche Kontinentalverbindung beiderseits verbreitet hat. Die Zeit, in der sich diese und die vorstehend erwähnten Gattungen über diese nordpazifische Kontinentalbrücke verbreitete, liegt sicher weit zurück in der Tertiärperiode, vielleicht noch weiter zurück. Das können wir nicht genauer ermitteln. Jedenfalls haben sich die Arten und z. T. auch die Gattungen der Zopherinen später meistens stark differenziert.

Sibirisch-nordamerikanisches Element der Pleistozänzeit.

In viel jüngerer Zeit müssen diejenigen Arten sich über die nordpazifische Kontinentalbrücke verbreitet haben, welche sich teils in Nordostasien, teils weiter über Sibirien verbreitet finden. Ich meine hier nicht die Angehörigen der holarktischen Fauna insgesamt, sondern nur gewisse Arten, welche von Sibirien bis in das boreale oder subarktische Nordamerika verbreitet sind. Die Behringstrasse zwischen Nordostsibirien und Alaska war, wie NEUMAYR mitteilt, während der Diluvialzeit geschlossen. Die Arten konnten sich also von einem Kontinent zum andern verbreiten. Von Carabiden sind zu nennen *Carabus Vietinghovi* Ad. (Ostsibirien, Alaska, Hudsons-Bai), *Carabus meander* Fisch. (Ostsibirien, Hudsons-Bai), *Carabus Hummeli* Fisch. (Nordost-Russland, Sibirien bis Kamtschatka, Amur, etc., und Alaska), *C. truncaticollis* Esch. (Nord-Ural bis Kamtschatka, Behringstrasse, Alaska, höhere Gebirge Kaliforniens); —ferner *Cychrus angusticollis* Fisch., *Nebria bifaria* Mannerh., *Nebria frigida* F. Sahlb., *Notiophilus sibiricus* Motsch., *Amara glacialis* Mannerh., *Pterostichus adstrictus* Esch., *Pterostichus Nordqvisti* Sahlb., *P. punctatissimus* Rand., *P. mandibularis* Kirby, *P.*

empetricola Dej., *P. confusus* Motsch., *P. quadricollis* Mannerh., *P. subexaratus* Mannerh.;—ferner von anderen Coleopterenfamilien z. B. noch eine Melandryidenart, *Stenotrachelus Rouillieri* Motsch. (Ostsibirien, arktisches Amerika); von Elateriden *Cryptohypnus nocturnus* Esch. var. *bicolor* Esch. (Kamtschatka, Labrador); von Telephoriden *Podabrus callosus* J. Sahlb. (auf die Tschuktschen-Halbinsel beschränkt). Noch andere Arten sind auf die Tschuktschen-Halbinsel beschränkt, nämlich die Chrysomeliden *Chrysomela cavigera* J. Sahlb. und *Ch. magniceps* J. Sahlb. Von Curculioniden bewohnt der nordamerikanische *Lepidophorus lineatocollis* Kirby (Alaska, Canada, Colorado, Nord-Mexiko) auch die asiatische Seite der Behringstrasse, während *Lepyrus Nordenskjöldi* Faust auf der Tschuktschen-Halbinsel endemisch ist.—Dieses besondere amerikanische und teilweise endemische Element Nordostsibiriens erfordert noch eine besondere Aufmerksamkeit. POPPIUS schreibt in seiner *Abhandlung über die Coleopteren des arktischen Gebietes* (1910), p. 440, dass viele der auf der Tschuktschen-Halbinsel gefundenen Arten im Lena-Gebiete ganz fehlen. Unter den aus den Alaska-Tundren bekannten 30 Coleopteren-Arten sind nach demselben Autor 13 auch in Ostsibirien aufgefunden, teils auf den Tundren, teils in den Waldgegenden. Diese Arten sind nicht weiter westlich gefunden (sie mögen hier vielleicht noch gefunden werden), während viele Coleopterenarten Europas nicht mehr in Sibirien, höchstens in Westsibirien angetroffen werden. Diese diskontinuierliche Besonderheit finden wir auch bei *Lepidopteren*. *Anarta melaleuca* Thnbg. bewohnt Skandinavien, Lappland, Russland—Nordostsibirien—und Labrador; *A. Zetterstedti* Stdgr. Norwegen, Lappland—die Mongolei, etc.—Grönland und Labrador. *A. richardsoni* Curt. bewohnt Grönland, Labrador, und Novaja Semlja, in der Form *dovreensis* Stdgr. Norwegen, Finmarken, Lappland, und als Subsp. *asiatica* Stdgr. die Tschuktschen-Halbinsel. *Anarta cordigera* Thnbg. findet sich im arktischen Norwegen, Lappland, auf Gebirgen Mitteleuropas, im Ural—sowie in Ostsibirien—und Labrador. Es ist also in Sibirien eine breite faunistische Trennungslinie zu konstatieren. Diese beachtenswerte Tatsache mag auf geologische Vorgänge zurückzuführen sein, wie wir bei einem weiteren Eindringen in diese interessanten Verhältnisse herausfinden. Schon während der mittleren

Kreidezeit war das Gebiet des Kaspischen Sees und Aral-Sees bis zu dem Meerbusen des Ob ein sehr breiter Meeresarm, der Europa von Sibirien trennte (s. Karte von de LAPPARENT). Auch noch in den älteren Epochen der Tertiärzeit war diese breite Trennungslinie vorhanden. Von der folgenden Miocänzeit an war Europa mit Sibirien verbunden. Aber während der Pleistocänzeit erstreckte sich der Kaspische See wieder sehr weit nordwärts. Vergl. auch SCHARFF (*European Animals, their Geological History and Geographical Distribution*, 1907).

Das holarktische Element Asiens.

Die zahlreichen weit verbreiteten Gattungen Sibiriens und teilweise auch Mittelasien gehören hauptsächlich zu dem holarktischen Element. Die meisten Gattungen und viele Arten sind dieselben wie in Europa. Holarktische, also über die arktische und die temperierten Zonen Eurasiens und Nordamerikas verbreitete Gattungen sind z. B. die folgenden:

Carabiden: *Nebria*, *Pelophila*, *Leistus*, *Carabus*, *Cychrus*, *Elaphrus*, *Blethisa*, *Loricera*, *Notiophilus*, *Dyschirius*, *Clivina*, *Panagæus*, *Bembidium*, *Tachys*, *Patrobus*, *Pogonus*, *Badister*, *Oodes*, *Chlænium*, *Calathus*, *Platynus*, *Pterostichus*, *Amara*, *Harpalus*, *Stenolophus*, *Bradycellus*, *Acupalpus*, *Anisodactylus*, *Miscodera*, *Cymindis*, *Metabletus*, *Dromius*, *Blechnus*, *Lebia*, etc.; — *Cicindela*.

Staphyliniden: *Falagria*, *Amicha*, *Colpodota*, *Atheta*, *Allochra*, *Gyrophæna*, *Quedius*, *Philonthus*, *Xantholinus*, *Stenus*, *Cryptobium*, *Lathrobium*, *Scopæus*, *Stilicus*, *Lithocharis*, *Pæderus*, *Sunius*, *Tachyporus*, *Tachinus*, *Conosoma*, *Mycetoporus*, *Oxyphorus*, *Bledius*, *Oxytelus*, *Trogophleus*, *Olophrum*, *Homalium*, *Anthobium*, *Protinus*, *Micropeplus*, etc.

Silphiden: *Necrophilus*, *Silpha*, *Necrophorus*, *Agyrtes*, *Pteroloma*, *Choleva*, *Colon*, *Anisotoma*, *Liodes*, *Agathidium*, etc.

Scydmaeniden: *Scydmaenus*, etc.

Pselaphiden: *Batrissus*, *Tychus*, *Bryaxis*, *Trimium*, *Euplectus*, etc.

Mycetophagiden: *Mycetophagus*, *Triphyllus*, *Litargus*, *Typhæna*, *Berginus*, *Diplocælus*.

Dryopiden (Parniden): *Dryops* (*Parnus*), *Elmis*, etc.

Scarabaeiden: *Geotrypes*, *Odontæus*, *Bolboceras*, *Aphodius*, *Ægialia*, *Psammodius*, *Trox*—*Sinodendron*, *Platycerus*, *Dorcus*, *Lucanus*—*Serica*, *Polyphylla*, *Hoplia*, *Anomala*—*Trichius*, *Gnorimus*, *Osmoderma*, *Valgus*.

Elateriden: *Corymbites*, *Elater*, etc.

Buprestiden: *Chalcophora*, *Dicerca*, *Pæcilonota*, *Buprestis*, *Anthaxia*, *Chrysobothris*, *Agrilus*.

Byrrhiden: *Cytilus*, *Byrrhus*, *Syncalypta*.

Melandryiden: *Melandrya*, *Phryganophilus*, *Zilora*, *Eustrophus*, etc.

Pythiden: *Pytho*, etc.

Pyrochroiden: *Pyrochroa*.

Meloiden: *Meloe*, *Zonitis*, *Epicauta*.

Cisteliden: *Cistela*, *Cteniopus*.

Tenebrioniden: *Helops*, *Scaphidema*, *Diaperis*, *Crypticus*, *Phaleria*, *Uloma*, *Eledona*, *Boros*.

Chrysomeliden: *Luperus*, *Galeruca*, *Gonioctena*, *Chrysomela*, *Pachybrachys*, *Cryptocephalus*, *Hæmonia*, *Donacia*.

Cerambyciden: *Tragosoma*, *Prionus*, *Spondylis*, *Crioccephalus*, *Ascum*, *Tetropium*, *Callidium*, *Rosalia*, *Clytus*, *Necydalis*, *Leptura*, *Pachyta*, *Acmaeops*, *Brachyta*, *Rhagium*, *Toxotus*, *Monohammus*, *Oberca*, etc.

Scolytiden: *Hylastes*, *Xyleborus*, *Tomicus*.

Curculioniden: *Attelabus*, *Tanymecus*, *Phyllobius*, *Phytonomus*, *Lepyrus*, *Pissodes*, *Plinthus*, *Hylobius*, *Dorytomus*, *Grypidius*, *Smicronyx*, *Tychius*, *Balaninus*, etc.

Viele der vorstehenden Gattungen sind nicht rein holarktisch, sondern bewohnen auch andere Regionen der Kontinente; sie sind aber wesentliche Bestandteile sowohl der palaearktischen als auch der nearktischen Region. Dieses holarktische Element stammt wahrscheinlich grösstenteils oder vollständig aus der Tertiärzeit. Die Gattungen konnten sich über die nordpolaren und anderen Kontinentalverbindungen verbreiten.

Mandschurisch-japanisches Element.

In Ostasien folgt auf die ostsibirische Fauna südwärts die mandschurisch-japanische Fauna. Diese weist im Norden neben vielen endemischen Gattungen und Untergattungen, welche

das eigentliche *mandschurisch-japanische Element* bilden, echt paläarktische Gattungen und noch manche europäische Arten auf. Im Süden, besonders in China und Süd-Japan finden sich bereits tropische Formen, welche an Südasien erinnern. Eine leitende Gattung für den paläarktischen Charakter Chinas und Japans ist die Collectiv-Gattung *Carabus*, die sich hier in eigenartigen und teilweise sehr schönen Formen entfaltet hat: *Acoptolabrus*, *Coptolabrus*, *Damaster*, *Adamaster*, *Scambocarabus*, *Eupachys*, *Ohomopterus*, *Isiocarabus*, *Apotomopterus*, *Leptocarabus*, *Hypsocarabus*, *Eocarabus*, *Cratocranion*, *Cryptocchenus*, *Piocarabus*, *Diocarabus*, *Archæocarabus*. Daneben giebt es viele indische Formen, die hauptsächlich Süd-China bewohnen, aber in manchen Gattungen auch die japanische Fauna kennzeichnen. Zahlreiche endemische Gattungen von Coleopteren sind gleichfalls charakteristisch für das mandschurisch-japanische Gebiet, von *Melolonthiden* z. B. *Hypochrus*, *Heptophylla*, *Hexatænius*, *Exolontha*, *Hecatomnus*, *Pollaplonyx*, *Lachnota*, *Holotrochus*, *Trematodes*, etc.; von *Tenebrioniden* die Gattungen *Idisia*, *Pseudadrus*, *Micropedinus*, *Dicræosis*, *Addia*, *Enanca*, *Thydemus*, *Elixota*; von *Cerambyciden* *Mallambyx*, *Allotræus*, *Stenodryas*, *Leptoxenus*, *Mantitheus*, *Paraphilus*, *Macropidonia*, *Pseudosieversia*, *Sieversia*, etc.

Die Collectivgattung *Carabus* war in Ostasien sicher schon in der Jurazeit vertreten; denn Neuholland wird von der Gattung *Pamborus* bewohnt, welche mit *Carabus* ausserst nahe verwandt ist. *Pamborus* ist ein altertümlicher Rest des Carabenstammes, der sich über den jurasischen Kontinent von Ostasien bis Neuholland ausbreitete. Seit jener Zeit sind aus der Collectivgattung *Carabus* neue Artengruppen entstanden, besonders in Central- und Ostasien, wo sie sich formenreich entfalteten. Dieses ist ein Abbild auch für andere Gattungen.

Das tropische Element Asiens.

Es ist meines Erachtens garnicht richtig, anzunehmen, das indische Element in China-Japan habe sich von Südasien her bis hierher verbreitet. Im Gegenteil. Bei der ursprünglichen Verbreitung der Tiere aus der Polargegend und den sich südlich anschliessenden Verbreitungszentren (Holarktis—Central- und Ostasien) bildete sich in Ostasien allmählich das thermophile

Element und differenzierte sich bereits hier in zahlreiche Gattungen. Dieses thermophile Element verbreitete sich über Hinter-Indien und wurde noch formenreicher. In Vorder- und Hinter-Indien nebst Indonesien entfaltete sich das umfangreiche tropisch-asiatische oder indische Element. Vorder-Indien war während der Jurazeit durch einen Meeresarm von Hinter-Indien getrennt (NEUMAYR). Diese Trennung scheint noch während der alttertiären Zeit bestanden zu haben. Die Fauna beider Halbinseln differiert noch in der Jetztzeit stark voneinander. Hinter-Indien bildete in jener alten Zeit zusammen mit China den sinischen Kontinent (ARLDT). Vorder-Indien hatte gegenüber Hinter-Indien stets seine gesonderte Fauna, da es während der mesozoischen Zeit mit Madagaskar und während der Tertiärzeit mit dem mediterraneischen Gebiet in engerer Beziehung gestanden hatte. Doch machen sich Beziehungen zwischen Südwest-China und Vorder-Indien bemerkbar. Indien war aber von dem Hochland Central-Asiens schon von Alters her getrennt. Wir wissen von den Geologen (vergl. NEUMAYR), dass schon in der mesozoischen Zeit der Himalaya eine Fauna beherbergte, die der nordischen verwandt war. Eine gute Illustration zu dem vorstehenden zoogeographischen Verhältnis finde ich in der Verbreitung der Lucaniden. Die beiden Genera *Pseudolucanus* und *Lucanus*, von denen das erstere morphologisch inferior, das letztere superior erscheint, bewohnen Asien, Europa mit den mediterraneischen Ländern und Nordamerika. Die meisten Arten derselben bewohnen Ostasien und das Gebiet des Himalaya nebst Dependancen. Die Wiege dieser beiden eng zusammengehörigen Gattungen ist jedenfalls der Südrand Central-Asiens und Ostasien, von wo aus sich ein Zweig über Kleinasien, das Mediterraneum und Mittel-Europa, der andere sich nach Nordamerika gewendet hat. Die Dorcinen verhalten sich ähnlich. Dagegen bewohnen die deszendenten Gattungen der Lucaninen Süd- und Südostasien nebst Indonesien, nämlich *Rhætus*, *Pseudorhætus*, *Rhætulus*, *Hexarthrius* und *Alotopus*. Eine andere Hauptgruppe der Lucaniden sind die Odontolabinen, welche mit 3 Gattungen und 73 Arten (nach dem neuesten Cataloge van Roon's) auf Süd- und Südostasien nebst Indonesien beschränkt sind. Allein schon diese Gruppe der Lucaniden ist bezeichnend für den Reichtum an Gattungen und Arten

dieser Familie in Asien, was in keinem anderen Kontinent der Fall ist. Das ist ähnlich so mit den Cladognathinen, der sich hier anschliessenden Gruppe derselben Familie. Mehr als 120 Arten in 7 Gattungen dieser Gruppe kommen in Südasien, auf den Sunda-Inseln und in Melanesien vor. Demgegenüber sind tatsächlich nur 3 Arten der Cladognathinen aus Neuholland bekannt, welche zu der indo-afrikanischen Gattung *Metopodontus* gehören. Die geringe Beteiligung dieser Gruppe, sowie das Fehlen der Lucaninen und Odontolabinen in Neuholland, die Abwesenheit derselben in Archiplata und das Fehlen indigener Gattungen in Afrika und Madegassien fordern die Annahme, dass diese Gruppen auf der Nordhemisphäre, und zwar in Ost- und Südasien ihren Ursprung genommen haben. Sie sind dann von hier aus weiter verbreitet, von Ostasien nach Amerika, von Indien aus nach Afrika. Die amerikanischen Gattungen sind vielleicht über Ostasien nach Amerika gekommen.

Das indische Element ist besonders durch die Odontolabinen, Cladognathinen und die genannten Gattungen der Lucaninen schon gut charakterisiert. Die Anfänge zu diesen Gruppen der Lucaniden sind in Ostasien zu suchen. Dasselbe gilt von anderen charakteristischen Familien der Coleopteren des Indischen Gebiets, besonders der Cetoniiden, Buprestiden, und Cerambyciden.

Die Differenzierung und Verbreitung dieser Gruppen und Gattungen kann nur in die Tertiärzeit fallen, als Neuholland von Asien bereits separiert war. Denn sonst müssten sich in Neuholland Arten von Lucaninen und Odontolabinen finden. Die Radix der Cladognathinen ist im mesozoischen Zeitalter zu suchen.

Über die Beziehungen der Sunda-Inseln (Indonesien) zu dem kontinentalen Indien können interessante biogeographische Studien angestellt werden. Die Geologie ist auch hier wieder eine wichtige Hilfswissenschaft. Es ist wohl sicher, dass die Sunda-Inseln früher mit Indien kontinental verbunden waren, und dass grosse Einbrüche am Ende der Tertiärzeit den jetzigen insularen Zustand zur Folge gehabt haben. Grosse und kleine Inseln mit zahlreichen Vulkanen sind als Zeugen jener grossen Katastrophen übrig geblieben. Wie verhalten sich nun die einzelnen Inseltaunen zueinander und zu den Faunen des

Kontinents? Es zeigt z. B. Java eine nähere Verwandtschaft zu Indien als Sumatra, Borneo und Malakka. Eine Erklärung dafür findet sich bei WALLACE. Ferner ist Malakka mit Sumatra, Java und Borneo näher verwandt als mit dem Kontinent; es ist gewissermassen eine Insel, die in jüngster geologischer Zeit mit dem Kontinent wieder verbunden wurde. Andererseits sind die Faunen dieser Inseln teilweise recht ähnlich, trotz mancher Differenzen. Auch ist die Fauna jeder Insel ziemlich homogen; doch sind Verschiedenheiten im Westen und Osten, im Norden und Süden bemerkbar. Auf Celebes sind die Faunen der einzelnen Teile dieser stark verästelten Insel viel verschiedener voneinander als auf den anderen Inseln. Die Landschnecken des Nordens (Menado) sind nach E. v. MARTENS von denen des Südens (Makassar) fast alle ganz verschieden; jene stimmen mehr mit denen der Philippinen, diese mehr mit denen von Java und Flores überein. Die Landschnecken Ost-Borneos haben einzelne Anklänge an Süd-Celebes. Celebes bestand nach P. und F. SARASIN aus mehreren Inseln, was ganz plausibel erscheint. In Folge einer späteren Hebung müssen die Teile dann verbunden worden sein. Nach JACOBI ist Celebes seit der Miocänzeit von Indien getrennt.—Das kontinental-indische Element der Sunda-Inseln ist von dem insularen Element zu scheiden; ebenso ist das malayische Element der Inselfaunen festzustellen. Auch kommen Beziehungen zu den Molukken und Madagaskar in Betracht. Die Philippinenfauna zeigt nördliche und südliche Elemente. Das nördliche Element resultiert ohne Zweifel aus einem ursprünglichen Zusammenhange mit Ostasien einschliesslich Japan. Während der Tertiärzeit bildeten die Philippinen mit den Liukiu-Inseln und Japan ohne Zweifel eine Kontinentalmasse. Die Philippinenfauna ist von der Fauna der Sunda-Inseln recht verschieden. Obgleich auf den Sunda-Inseln sehr viel Insekten gesammelt und die Faunen derselben recht gut bekannt sind, so ist doch darüber weder etwas Zusammenhängendes noch Vergleichend-zoogeographisches von Belang publiziert. Es giebt aber Vorarbeiten in manchen Monographien und Catalogen. Auf alle die inhaltreichen obigen Fragen kann hier nicht eingegangen werden. Es ist noch zu erwähnen, dass in dem tropischen Teile Asiens auf den

Gebirgen das *paläarktische Element* auftritt. Auf Gebirgen Nordindiens finden sich z. B. Arten von *Carabus*. Auch auf den Gebirgen der Philippinen finden sich Anklänge an paläarktische Arten des Himalaya. Das weist auf die alte (mesozoische) Landverbindung mit dem Kontinent hin. Andererseits sind Beziehungen zu Neu-Guinea vorhanden, z. B. durch Arten der Pachyrhynchinen. Diese Untersuchungen und Feststellungen sind bisher nur wenig gemacht; sie verdienen aber eine ausgiebige Bearbeitung.

Das tropisch-afrikanische Element Südasiens.

Neben den endemischen Angehörigen des tropisch-asiatischen Elements giebt es in Südasien noch Gattungen, die auch über das tropische Afrika verbreitet sind. Besonders gehören hierher z. B. von *Cerambyciden* die Gattungen *Macrotoma*, *Anæme*, *Apioccephalus*, *Hypoëschrus*, *Plocæderus*, *Diorthrus*, *Pachydissus*, *Derolus*, *Margitus*, etc.; von *Buprestiden* besonders die Gattung *Sternocera*; von *Cetoniiden* identische oder nahe Verwandte der Ceratorhinen, Heterorhinen, genuinen Cetoniinen, Diplognathinen, Clinteriinen, Glycyphaninen, Cremastochilinen, etc.; von *Copriden* besonders die Gattungen *Catharsius* und *Heliocopris*. Es ist sicher, dass die Arten dieser beiden Gattungen, zumal die riesigen Mistkäfer der Gattung *Heliocopris* aus Afrika nach Südasien gewandert sind, wahrscheinlich während der jüngsten Tertiär- und Pluvialzeit. Ich nehme die afrikanische Herkunft dieser Copriden deswegen an, weil der Schwerpunkt dieser beiden Gattungen mit ihren zahlreichen Arten und phylogenetischen Stufen in Afrika ihre breite Basis haben, während die wenigen Arten Süd- und Südostasiens nur als Ausläufer der grösseren Arten Afrikas erscheinen. Diese und ähnliche zoogeographische Verhältnisse finden sich noch in vielen anderen Coleopterenfamilien.

Die nahe Verwandtschaft mancher Arten der afro-indischen Gattungen lässt annehmen, dass die Zeit ihrer Verbreitung von Afrika nach Indien in eine junge geologische Epoche fällt. *Heliocopris midas* F. (Indien) stimmt mit *H. isidis* Latr. (Unter-Aegypten bis Südafrika) fast überein. *Heliocopris bucephalus* F. (Indien) ist dem *H. colossus* Bat. (tropisches Afrika) nahe

verwandt. *Scarabæus gangeticus* Cast. (Vorder-Indien, Ceylon, etc.) ist von *S. isidis* Cast. (West- und Ostafrika, Aegypten, Persien) wohl nicht zu unterscheiden. Beispiele solcher Art giebt es mehr.

Es fehlt auch nicht an vollkommener Identität mancher Arten Indiens und Afrikas, so dass diese Arten als afro-indische zu bezeichnen sind: *Onthophagus Martini* Orb. (Vorder-Indien—Südarabien, Nordostafrika), *O. ochreateus* Orb. (ebenso), *O. semicinctus* Orb. (Vorder-Indien) fast identisch mit *O. Abeillei* Orb. (Nordostafrika), *O. gazella* F. (Indien, Ceylon, Arabien, das ganze tropische und Südafrika, Madagaskar), *Trox procerus* Hrld. (Indien, Arabien, Nordostafrika), *Cicindela aulica* Dej. (Senegambien, Vorder-Indien) *Glycia ornata* Kl. (Vorder-Indien, Nordostafrika). Es giebt noch mehr afro-indische Coleopterenarten, die hier nicht alle aufgezählt werden können.

Zum Teil zeigen es schon die vorstehend aufgeführten Arten, welchen Weg die afro-indischen Coleopteren bei ihrer Ausbreitung genommen haben. Nordostafrika—Arabien—Persien—Beludschistan—Indien bilden die Wanderstrasse, welche Afrika mit Indien verbindet. Die jetzt trennenden Barrièren "Rotes Meer" und "Persischer Golf" sind gegenstandslos, da ihr Einbruch sicher jungen geologischen Datums ist. Wenigstens steht das für das Rote Meer fest. "Das Rote Meer trennt erst seit dem Pliocän Arabien von Afrika" sagt STROMER VON REICHENBACH. Der Indische Ozean existierte schon von Anbeginn der Tertiärperiode. Wie noch jetzt gab es schon damals Korallenriffe in denselben Gegenden der Küste Ostafrikas. Auch Nummuliten und ähnliche grosse, kalkschalige Foraminiferen aus dem Alttertiär, Bewohner warmen Seichtwassers, finden sich in Ostafrika bis zur Breite des Südendes Madagaskars (nach demselben Autor). Es waren also während der letzten Epochen der Tertiärperiode genügend Wege für die Ausstrahlung eines tropisch-afrikanischen Elements durch Südasien nach Vorder-Indien vorhanden.

Das lemurische Element Südasiens.

Während der Tertiärperiode waren die nördlichen Kontinente von den südlichen Kontinenten getrennt, und letztere

isoliert. Während der Oligocänzeit erscheint die Fauna Indiens ziemlich selbständig, zeigte aber Beziehungen zu Madagassien, mit dem Indien in kontinentaler Beziehung stand (Lemurien). Diese alte Verbindung bestand schon zur Jurazeit und reichte bis Südafrika (NEUMAYR). In der Indischen Fauna ist das *lemurische Element* zuweilen deutlich erkennbar. Die eigenartige Gruppe der *Sceleocanthinen*, welche zu den Prioniden gehört, enthält 4 afrikanische Genera (*Cantharoprion*, *Cantharoctenus*, *Cantharoplatys*, *Cantharocnemis*) und 1 australisches Genus (*Sceleocantha*). Von der ostafrikanischen Gattung *Cantharocnemis* kommt eine Spezies in Bombay und Ceylon vor. Diese Art wäre als ein lemurisches Element anzusehen, unter der Annahme, dass die Gruppe in Madagassien ausgestorben sei. Die Entelinen, eine Gruppe der Tenebrioniden, bewohnen das Capland, Natal, Deutsch-Ostafrika und Madagaskar, aber auch Malacca und Bengalen; in ähnlicher Weise die Pycnocerinen, eine andere Gruppe der Tenebrioniden, das tropische Afrika, 2 Gattungen jedoch (*Phengonius* und *Ædiatorix*) Borneo resp. Sumatra und Java. Diese und noch manche andere sind also gleichfalls Gattungen des lemurischen Elements in Süd-Asien.

Das mediterraneische Element in Südwest-Asien.

In der Fauna Südwest-Asiens tritt die mediterraneische Verwandtschaft sehr stark hervor; die Beziehungen der Gattungen dieses Teiles des Kontinents Asien zu Central-Asien sind jedoch meistens nur gering. Zahlreiche Gattungen der Coleopteren Südwest-Asiens unterscheiden sich von den auf die turanische Provinz beschränkten Gattungen. Auch dieser biogeographische Zustand ist auf geologische Besonderheiten zurückzuführen. Während der älteren Epochen der Tertiärzeit war Südwest-Asien (Kleinasien, Armenien, Persien) im Norden von einem breiten Meeresarm (die Sarmatische See) begränzt, welcher das Schwarze Meer mit dem Kaspischen Meer verband und sich nach Osten hin erstreckte. Später wurde dieser breite Meeresarm eingeengt, im Pliocän schrumpfte er sehr zusammen. Das Schwarze Meer war aber vom Mittelmeer noch getrennt, und der Kaukasus bildete eine Insel. Währenddessen hatte sich die südwestasiatische Fauna zu einem gewissen Grade

von Beständigkeit ausgebildet, ebenso die turanische Fauna, besonders die steppicolen Gattungen. Charakteristisch sind für Südwest-Asien z. B. viele Subgenera von *Carabus* und verwandte Gattungen, nämlich *Procerus* (auch in Südosteuropa), *Procrustes* (auch in Südost- und in übrigen Europa), *Procrustocarabus*, *Procrusticus*, *Oxycarabus*, *Chætocarabus*, *Lamprostus*, *Lipaster*, *Ischnocarabus*, *Chætomelas*, *Heterocarabus*, *Deutero-carabus* (auch in Südosteuropa), *Mimocarabus*. Alle diese Untergattungen von *Carabus* fehlen in der benachbarten turanischen Provinz und im übrigen Asien.

EUROPA.

Die Tierwelt Europas hat hier kein eigenes altes Verbreitungszentrum, wie ein solches in Asien dem Forscher sich darbietet. Die nächste Verwandtschaft der Gattungen und Arten Nord- und Mitteleuropas findet sich in Sibirien. Diese Verwandtschaft ist so gross, dass viele Arten dieselben und auch die Gattungen meistens dieselben sind. Doch giebt es manche endemische Arten in Nordeuropa, was beachtenswert ist. Skandinavien, Lappland und Finland sind in ihrem Zusammenhange ein uraltes kontinentales Massiv, auf dem manche Arten aus älteren geologischen Perioden konserviert zu sein scheinen. Das übrige Europa bestand lange Zeit hindurch nur aus Inseln, noch während der älteren Epochen der mesozoischen Zeitalters, besonders während der Jurazeit, und war sonst weit und breit vom Meere überflutet. Nur das Nordland, Fennoskandia, ragte dauernd aus dem Urmeere hervor. Während der Kreidezeit wurde noch ein grosser Teil Nordrusslands und Mittlerrusslands nebst Novaja Semlja gehoben und mit Fennoskandien verbunden. Kleinere oder grössere Teile von England, Irland, Frankreich, Spanien, Italien, der Balkanhalbinsel waren inselartig. An der Stelle Mitteleuropas gab es nur einzelne Inseln. Diese Inseln an Stelle Mittel- und Südeuropas waren aber während der mesozoischen Zeit häufigen Wechseln von festem Lande und Meeresbedeckung unterworfen. Die Entwicklung reicher und selbständiger Faunen und Floren war daher hier nicht möglich. Die Bestandteile des mittel- und südeuropäischen Archipels verbanden sich erst im Laufe der Tertiärzeit nach

und nach, um am Schlusse der Tertiärzeit ein geeinigtes Europa zu bilden. Aber auch während dieser langen Zeitperiode waren die verschiedenen Teile Europas noch wiederholt untergetaucht und wieder gehoben.

Wenn wir nun damit rechnen, dass die Entstehung neuer Gattungstypen nur eine beschränkte war, so nehmen wir andererseits wahr, dass Europa durch Zuwanderung von anderen Kontinenten her bevölkert werden konnte. Während des mesozoischen Zeitalters, besonders während der Juraperiode, war der grosse Kontinent Nordamerika, mit dem auch Grönland und Island verbunden waren, ostwärts so umfangreich, dass er im Norden fast an Europa heranreichte und nur durch die schmale Shetlandstrasse von Skandinavien getrennt war (NEUMAYR). Eine Einwanderung von Gattungen aus Nordamerika nach Europa ist daher sehr annehmbar, zumal eine wirkliche kontinentale Verbindung vorgekommen sein mag, die infolge des Untergangs und der Submersion von Teilen Westeuropas jetzt nicht mehr erkennbar ist. Es war dann möglich, dass nicht nur Kleintiere (Insekten, etc.), sondern auch Saurier aus der reichen Kreidefauna Nordamerikas nach Europa einwanderten.

Auch mit Asien trat Europa in immer engeren Konnex. Während der Jurazeit bedeckte ein weites Meer Osteuropa und ganz Sibirien, aus dem nur das Uralgebirge als Gebirge herausragte. Aber während der Kreidezeit fanden in Nord- und Osteuropa, sowie in Nordasien grosse kontinentale Hebungen statt, infolgedessen eine russisch-sibirische und später eine russisch-turanische Annäherung bemerkbar wurde, die bereits während der älteren Tertiärzeit zunahm. Alle diese kontinentalen Anschlüsse machen es noch wahrscheinlicher, dass Europa weniger von innen als von aussen her bevölkert wurde.

Schon die geologische Tatsache, dass Nordeuropa, besonders Fennoskandia seit der Jurazeit und insgesamt mit dem grössten Teile Russlands seit der Kreidezeit, der einzige grössere Kontinental-Komplex in Europa war, macht es sehr wahrscheinlich, dass die Tierwelt Europas während der mesozoischen Zeit sich zum grössten Teile auf den Norden konzentrierte, vielleicht in Verbindung mit England, Belgien und Teilen Mitteleuropas. Hiermit soll aber nicht gesagt sein, dass hier ein biogeo-

graphisches Entwicklungszentrum war. Die grosse Nähe Nordamerikas, besonders während der Jurazeit und wohl auch während der Kreidezeit und die Verbindung Fennoskandiens mit Nordamerika (*nearktoskandinavischer Kontinent*) mindestens während der älteren Tertiärzeit (wahrscheinlich schon während des mesozoischen Zeitalters) lassen uns annehmen, dass hier ein Austausch zwischen den beiden borealen Kontinenten und vielleicht hauptsächlich eine Zuwanderung von Nordamerika nach Nord- und Nordwesteuropa stattfand. Vielleicht nahmen auch England, Belgien und Nordfrankreich daran als Halbinseln des nearktoskandinavischen Kontinents teil. Das holarktische Faunengebiet war während der Kreidezeit gewiss noch nicht vorhanden. Nordamerika östlich von den Rocky Mountains in Verbindung mit dem borealen Anhang bildete zusammen mit Fennoskandia den nearktoskandinavischen Kontinent, während wohl Nordost-Asien mit Nordwest-Amerika einen nordpazifischen Kontinent bildeten. Noch während der älteren Tertiärzeit mag diese abweichende Konfiguration der Nordkontinente bestanden haben.

Das holarktische Element.

Es war wohl während der letzten Epochen der Tertiärzeit, als sich die holarktische Fauna in ihrer Gesamtheit ausbildete. Nach der früheren Trennung der borealen Faunen fand ein teilweiser Ausgleich durch die weitere Ausbreitung der Genera infolge günstiger Kontinentalverbindung zwischen Europa und Nordamerika und einer günstigen Ausbildung der Klimate statt. Nach SCHARFF bestand die Kontinentalverbindung im Miozän oder Pliozän; ihr Südrand reichte von Grossbritannien bis Neu-Fundland. Während der Pleistozänzeit wurde Grönland von Europa und Amerika getrennt. Die in Grönland einheimischen Arten von Tiergattungen, welche jetzt dort ihre Heimat haben, müssen also die Eiszeit dort überdauert haben. Jedenfalls war also Nordwesteuropa am Ende der Tertiärzeit mit Nordamerika verbunden. Dasselbe müssen wir für Nordostasien und Nordwestamerika annehmen, wo die zahlreichen Vulkanreihen der Aläuten, Kamtschatkas, der Kurilen, u.s.w. sicher erst in jünger geologischer Zeit zeugen grösserer Kata-

strophen, Einstürze und Senkungen waren. Also auch für den nördlichsten Teil des Pazific ist eine Kontinentalbrücke selbstverständlich. Ueber diese zirkumpolare Kontinentalmasse, die vielleicht von Amerika oder Eurasien aus über den Nordpol hinwegreichte, verbreitete sich unter einem etwas günstigerem Klima am Ende der Tertiärzeit das boreale Tierleben, und bevölkerte das paläarktische und nearktische Gebiet. Die Zahl der Europa, Nordasien, und Nordamerika gemeinsamen Gattungen ist ziemlich gross. Es ist das *holarktische Element* in jedem dieser Kontinente. Die hauptsächlichen Coleopterengattungen dieses Elements sind bereits auf p. 445 in dem Kapitel "Asien" aufgezählt. Die meisten dieser holarktischen Arten sind über die ganze paläarktische und nearktische Region verbreitet.

Das glazialzeitliche Element Nordeuropas.

Nachdem beim Eintritt der Glazialzeit die Fauna Nordeuropas grossenteils nachteilig beeinflusst, meistens vernichtet oder südwärts zurückgedrängt worden war, schien das Leben in den Ländern des Nordens (also in der borealen Zone eines Teiles des holarktischen Gebietes) fast ausgestorben. Manche endemische, in Eurasien auf die nördlichen Länder beschränkte Arten von Insekten machen es wahrscheinlich, dass sie hier die Eiszeit an geschützten Orten überdauert haben. Von Coleopteren gehören z. B. hierher :

Carabiden : *Trachypachys Zetterstedti*, *Diachila polita* und *arctica*, *Elaphrus lapponicus*, *Bembidium Güntheri*, *lapponicum*, *pallidipenne*, *Palmeni*, *cupripenne*, *concinnum*, *Grapei*, *islandicum*, *contaminatum* und *nigricorne*, *Trechus Rathkei*, *Harpalus nigratarsis*, *Acupalpus Thomsoni*, *Trichocellus Mannerheimi*, *Amara curvica*, *nigricornis*, *melanocera*, *littorea*, *cyanocnemis*, *interstitialis*, *sylvicola* und *longiceps*, *Pterostichus boreellus*, *arcticola*, *aquilonius*, *fragilis*, *gelidus*, *deplanatus* und *vermiculosus*, *Agonum Mannerheimi* und *consimile*.

Halipiden : *Haliplus lapponus*, *transversus*, *apicalis*, etc.

Dytisciden : *Codambus Marklini*, *Hydroporus arcticus*, *fenicus*, etc., *Agabus serricornis*, *fuscipennis*, *Zetterstedti*, u.s.w., *Ilybius acnescens*, *similis*, etc., *Colymbetes dolabratus* und *melanopterus*.

Staphyliniden : *Micralymma marinum*, *Porhodites fenestralis*, *Cylletron nivale*, *Olophrum boreale*, *Mycetoporus lapponicus*, *debilis*, *crassicornis* und *aqualis*, *Tachyporus obscurellus*, *Oxypoda islandica*, *Sahlbergi*, u.s.w.

Silphiden : *Silpha* (*Thanatophilus*) *lapponica*, *Anisotoma punctulata*, *puncticollis*, u.s.w.

Malacodermaten : *Cantharis* (*Anolisus*) *lapponica*.

Coccinelliden : *Hippodamia arctica*, *Coccinella transversoguttata* var. *ephippiata*, etc.

Auf Spitzbergen ist *Orchestes flagellum* endemisch, anderswo nicht gefunden (POPPIUS, *Die Col. d. arkt. Gebietes*, 1910, p. 440).— Island ist in dieser Beziehung ebenfalls eigenartig. Hier giebt es keine einzige rein arktische Art, aber zahlreiche boreale, auch viele südliche Arten, die in anderen nordischen Gegenden nicht anzutreffen sind. Im Ganzen stimmt die Fauna mit derjenigen Nordeuropas überein. Es ist aber interessant, dass *Bembidinum islandicum* und *Atheta geysiri* auf Island endemisch sind. Vergl. POPPIUS l.c.

Das boreal-alpine Element.

Dieses Element umfasst Arten, welche diskontinuierlich verbreitet sind; es stammt aus der Zeit nach dem Rückzuge der grossen quartärzeitlichen Gletscher. Es sind Arten, welche meist in Nordeuropa und auf den Alpen Mitteleuropas leben, in den Zwischenländern aber meistens ausgestorben sind, an manchen, meist gebirgigen Punkten Mittel-Europas aber vereinzelt ebenfalls noch existieren. Dieses Element ist oft Gegenstand von Forschungen gewesen.

Das sibirische Element in Europa.

Seit dem Beginne der Quartärzeit (Pleistozänzeit) gab es sine grosse Barrière in äussersten Osten Europas gegen die Einwanderung von Angehörigen der sibirischen Fauna nach Westeuropa (vergl. p. 443). Das Weisse Meer erstreckte sich tief in Russland hinein. Das Schwarze Meer, das Kaspische Meer und der Aralsee bildeten zusammen eine einzige Wasserfläche, die sich weit nordwärts erstreckte. Dieses ausgedehnte System von Gewässern liess eine sibirische Einwanderung nicht zu

{JACOBY). Erst nach dem Schwinden der quartärzeitlichen Gletscherdecke und der Verminderung und Einschränkung der russischen Wasserfläche wanderte eine Steppen- und Buschsteppenfauna von Osten her nach Centraleuropa ein.

Es sind ziemlich zahlreiche Arten, welche in der Postglacialzeit aus Sibirien zu uns kamen; sie trugen dazu bei, der Fauna Europas den rezenten Charakter zu verleihen. Die holarktischen Gattungen und viele holarktische Arten hatten sich schon vorher über die nördliche Zone der Nordkontinente verbreitet. Die jungtertiäre und quartäre Einwanderung aus Westasien (grossenteils Südwestasien) hatten den rezenten Charakter der Fauna Europas bereits eingeleitet. Von sibirischen Coleopteren, deren Zahl noch grösser ist, als hier angegeben, seien folgende erwähnt:

Carabiden: *Cicindela campestris* L., *hybrida* L., *sylvatica* L. und *litoralis* F., *Elaphrus cupreus* Dft., *riparius* L., *Carabus clathratus* L., *granulatus* L., *cancellatus* Ill., *Calosoma investigator* Ill. (*dauricum* Motsch.), *Nebria Gyllenhali* Schh., *Pelophila borealis* Payk., *Clivina fossor* L., *Dromius sigma* Rossi, *Cymindis vaporariorum* L., *Loricera pilicornis* F., *Panagæus crux major* L., *Chlænius quadrisulcatus* Ill., *Patrobus septentrionis* Dej., *Calathus erraticus* Sahlb., *Dolichus halensis* Schall., *Anchomenus assimilis* Payk., *impressus* Pz., *sevpunctatus* L., *dolens* Sahlb., *puellus* Dej., *Bogemani* Gyll., *Pæcilus lepidus* F., *cærulescens* L. (*versicolor* Strm.), *Feronia niger* Schall., *Amara nitida* Strm., *communis* Pz., *vulgaris* Pz., *curta* Dej., *municipalis* Dft., *interstitialis* Dej., *erratica* Dft., *consularis* Dft., *Ophonus ruficornis* F., *griseus* Pz., *Harpalus æneus* F., *luteicornis* Dft., *neglectus* Dej., *picipennis* Dft., *Acupalpus exiguus* Dej., *Tachys nana* Gyll., *Bembidium quadrimaculatum* L., *quadripustulatum* Serv., *lamps* Hbst., *Andree* F., *obliquum* Strm., *varians* Ol., *prasinum* Dft., *velox* L.

Dytisciden: *Agabus Sturmi* Gyll., *conspersus* Marsh., *chalconotus* Pz., *Ilybius subæneus* Er., *angustior* Gyll., *Rhantus notaticollis* Pz., *bistriatus* Bergstr. (*adspersus* F.), *Hydroporus septentrionalis* Gyll., *erythrocephalus* L., *melanocephalus* Marsh., *obscurus* Strm., *nigellus* Mannerh., *atriceps* Crotch., *vittula* Er.

Gyriniden: *Gyrinus minutus* F., *marinus* Gyll.

Staphyliniden: manche Arten von *Atheta*, *Oxyhoda*, *Gyro-*

phæna, *Tachinus*, *Tachyporus*, *Conurus*, *Bolitobius*, *Mycetoporus*, *Quedius*, *Staphylinus*, *Philonthus*, *Xantholinus*, *Othius*, *Lathrobium*, *Pæderus*, *Stenus*, *Oxyporus*, *Oxytelus*, etc.

Scarabaeiden: *Platycerus caraboides* L., *Sinodendron cylindricum* L., — *Onthophagus austriacus* Pz., — *Aphodius erraticus* L., *fossor* L., *fætens* F., *fimetarius* L., *ater* Deg., *granarius* L., *borealis* Gyll., *sordidus* F., *plagiatus* L., *inquinatus* F., *pusillus* Hbst., *depressus* Kug., — *Geotrypes stercorarius* L., *Trox cadaverinus* Ill., *sabulosus* L., — *Phyllopertha horticola* L., *Melolontha hippocastani* F. — *Cetonia aurata* L. var., *marmorata* F., *metallica* Hbst., *Trichius fasciatus* L.

Buprestiden: *Dicerca ænea* L., *acuminata* Pall., *Pæcilonota decipiens* Mannerh., *Buprestis hæmorrhoidalis* Hbst., *flavopunctata* Deg., *Phænops cyanea* L., *Melanophila acuminata* Deg., *Anthaxia quadripunctata* L., *Chrysobothrys chrysostigma* L., *Agrilus viridis* L., *tenuis* Ratzb., *olivaceus* Ratzb., *Trachys minuta* L.

Cerambyciden: *Tragosoma depsarium* L., *Callidium violaceum* L., *æneum* Deg., *Tetropium luridum* L., *Asemum striatum* L., *Clytus rusticus* L., *capra* Germ., *Herbsti* Brahm, *Molorchus minor*, *Necydalis major* L., *Lamia textor* L., *Monohammus sartor* und *sutor* F., etc.

Das jungtertiäre westasiatische Element im rezenten Europa.

Nachdem die holarktische Fauna sich über das paläarktische Asien, Europa und das nördliche Nordamerika ausgebreitet hatte (während der Tertiärzeit), da waren die Gattungen meistens dieselben wie ein sehr grosser Teil der Gattungen der rezenten Tierwelt der genannten Kontinentgebiete. Das ersehen wir aus der Liste der holarktischen Genera (p. 445). Es gilt aber auch nur für die meisten Genera der rezenten Faunengebiete der Nordkontinente. Denn ein näherer Einblick zeigt uns bald, dass in der langen Reihe der holarktischen Genera manche Gattungen fehlen, welche in der rezenten Fauna wichtige Glieder der paläarktischen Region bilden. Warum fehlen diese Gattungen in der rezenten Fauna Nordamerikas? Warum sind sie in der rezenten Fauna Nord-, Mittel-, und Südeuropas enthalten?

So z. B. die Arten der Gattung *Melolontha*, die allgemein

bekannten Maikäfer, die weit und breit Europa bewohnen, aber in Nordeuropa in der arktischen Region nach SPARRE SCHNEIDER nicht mehr gefunden werden. Die Maikäfer erscheinen so wenig beachtenswert und so sehr alltäglich und kommun, dass wir unter gewöhnlichen Umständen kaum Veranlassung verspüren uns mit ihnen zu beschäftigen. Dasselbe gilt von den grossen Mistkäfern der Gattung *Geotrupes*, über die ebenfalls scheinbar wenig zu sagen ist. Und dennoch sind beide Gattungen in tiergeographischer Hinsicht sehr interessant. Wir finden das bald, wenn wir uns mit ihnen in vergleichender Weise beschäftigen. Schon die Tatsache, dass *Melolontha* in Amerika fehlt, *Geotrupes* aber über Nordamerika bis Mexiko verbreitet ist, lenkt unsere intimere Aufmerksamkeit auf diese Coleopteren. Die Frage nach der Verbreitung und der Ursache ihrer verschiedenen Verbreitung wird uns sogleich *in medias res* führen.

Melolontha ist über Nord- und Mitteleuropa in 2 Arten verbreitet: *vulgaris* und *hippocastani*. *M. vulgaris* bewohnt auch Teile von Spanien und Italien, die Balkanhalbinsel, Kleinasien, Armenien, und den Kaukasus. Dagegen ist die Heimat der *M. hippocastani* ebenfalls Nord- und Mitteleuropa, in Südeuropa anscheinend nur Mittel-Italien; in Asien bewohnt sie West- und Ostsibirien bis Irkutsk, sowie in der Abart *mongolica* Motsch. Transbaikalien und die Mongolei. Es ist anzunehmen, dass *M. hippocastani* von Sibirien her in Europa eingezogen ist. Dagegen hat *M. vulgaris* von Südwestasien aus Europa bevölkert. Dies ist um so wahrscheinlicher, da das Zentrum der Verbreitung der Gattung *Melolontha* West- bis Zentral-Asien ist. Hier, in Kleinasien, Syrien, Persien, Kaukasus, und Turkestan wohnen die übrigen Arten der Gattung.

Aus der rezenten Verbreitung von *Melolontha* über das paläarktische Gebiet und dem Fehlen dieser Gattung in Amerika ergibt sich, in Verbindung mit den zoogeographischen Verhältnissen Europas, die Schlussfolgerung, dass diese Gattung während der Tertiärzeit über Europa noch nicht so weit verbreitet war wie jetzt. Als die tertiärzeitliche Kontinentalbrücke zwischen Nordwesteuropa und Nordamerika noch existierte, war die asiatische Gattung *Melolontha* sicher noch nicht über Mittel- und Nordeuropa verbreitet; sie hätte sich sonst, wie andere Gattungen über die

nördliche Kontinentalpassage nach Amerika verbreiten müssen. Als die Gattung während der Pleistozänzeit von Asien her sich westwärts ausbreitete, war diese kontinentale Nordpassage verschwunden (SCHARFF), infolgedessen eine Ausbreitung nach Amerika unmöglich geworden.

Aehnlich verhalten sich die *Cetonia*-Arten. *C. aurata*, welche über Nord-, Mittel-, und Südeuropa verbreitet ist und in Nordeuropa bis Lappland gefunden wird, kommt ausserdem in mehreren Rassen in Kleinasien, Persien, in den Kaukasus-Ländern, Turkestan, im Tian-Schan und in Irkutsk vor. Nach LUCAS ist diese Art auch in Algerien nicht selten; sie ist dort hin wahrscheinlich über die italienisch-afrikanische Landbrücke während der Pliozänzeit gekommen.—Von den anderen Cetonien Nord- und Mittel-Europas scheint auch *Potosia cuprea* aus Westasien eingewandert zu sein, wo sie Transkaspien, Turkestan, den Kaukasus, Persien, Syrien, und Kleinasien (übrigens auch China und die Amur-Gegend) bewohnt. Von der Türkei aus ist sie weit und breit über Europa gewandert und in Norwegen nach SPARRE SCHNEIDER bis Tromsö ($69^{\circ} 12'$), in Schweden bis Lappland und nach J. SAHLBERG in Finland bis zum 68° gekommen.—*Pachnotosia marmorata* scheint aus Sibirien nach Europa gewandert zu sein; sie ist auch aus Ostsibirien bekannt, und auch in Kaukasus gefunden. In Nordeuropa kommt sie im Süden Schwedens, Norwegens und Finlands vor.

Auch die *Blaps*-Arten scheinen erst am Schlusse der Tertiärzeit und teilweise erst in der Postglazialzeit in Europa (wenigstens Mittel-Europa) eingewandert zu sein. Diese Gattung bewohnt hauptsächlich Central-Asien, Südost-Sibirien, die Mongolei, auch China, den Himalaya und Thibet, Kaschmir und Indien, auch Japan, dann Südwest-Asien, Südeuropa, und Nordafrika, in einigen Arten auch Mitteleuropa, von denen wenige bis Nordeuropa gekommen sind. Die übrigen Gattungen der Blaptinen kommen gleichfalls in Asien vor, hauptsächlich im Innern (Turkestan, Central-Asien, Altai, Mongolei, im Innern von China), wenige in Westasien, einige in Nordindien. *Gnaptor* bewohnt Südosteuropa.

Von den Caraben Südwestasiens sind nur wenige bis Mitteleuropa gewandert; die eingewanderten Formen sind morphologisch verändert. Das ist z. B. bei der *Procrustes*-Gruppe

der Fall, die aus Kleinasien stammt und wohl am Schlusse der Tertiärzeit sich nach Südosteuropa verbreitet, hat. Die Form *coriaceus* ist über Mitteleuropa weit verbreitet, aber erst in der Postglazialzeit nach Norddeutschland und Nordeuropa gewandert. Nach Gross-Britannien ist *P. coriaceus* nicht gekommen, obgleich dieses Inselland noch während der Diluvialzeit mit dem Kontinent verbunden war.

Es scheint, dass das langgestreckte, von Süddeutschland durch Oesterreich-Ungarn und Südrussland bis Chinesisch-Turkestan reichende Sarmatische Meer in den letzten Epochen der Tertiärzeit eine wirksame Barrière gegen die Einwanderung von Tieren aus Südwest-Asien war. Nach dem Verschwinden oder Einschrumpfen dieser breiten und langen Wasserstrasse während der Quartärzeit wurden die Verbreitungswege frei, sowohl für Tiere wie für Pflanzen. Es ist das sogenannte *Pontische Element*, welches seit jener Zeit von Südosteuropa in nordwestlicher Richtung sich ausbreitete. Von Coleopteren nenne ich z. B. *Cicindela literata* Sulz. an der Meeresküste in Ost- und Westpreussen, sonst in Mähren, Oesterreich, Ungarn, Siebenbürgen, Südrussland bis Sibirien; *Abax carinatus* Dft. in Schlesien, Oesterreich, Ungarn; ferner *Chlœnius festivus* F. (Schlesien), *Carabus scabriusculus* Ol., *C. hungaricus* F., *Cetonia hungarica* Hbst., *Capnodis cariosa* Pall. (Oesterreich),—von Neuropteren *Acanthaclisis occitanica* in Ostpreussen (HAGEN);—schliesslich von Orthopteren *Ephippiger vitium* Serv. bei Thorn und Marienwerder und *Barbidistes constrictus* Pr. bei Marienwerder (La Baume).

Die Gattungen *Broscus*, *Pristonychus*, *Sphodrus*, *Pæcilus*, *Mylabris*, *Cerambyx*, *Agapanthia*, *Phytæcia*, und manche andere Gattungen sind wohl gleichfalls erst dann nach Südeuropa und Mittel-Europa gekommen, als die Kontinentalbrücke zwischen Nordwesteuropa und Nordamerika verschwunden war; denn auch diese Gattungen fehlen in Nordamerika. *Pristonychus*-Arten sind nachträglich dorthin verschleppt. Auch Arten von *Pedinus*, *Microzoum* und *Opatrum* fehlen in Nordamerika. Von Parniden fehlen hier *Potaminus* und *Potamophilus*; *Parnus* (der jetzt *Dryops* heisst) ist in Nordamerika sparsam vertreten, *Elmis* zahlreich. Eine besondere Gattung ist in Nordamerika die merkwürdige archaistische Gattung *Psephenus*.

Nach der Trennung der letzten Kontinentalverbindung

Nordwest-Europa—Nordamerika bekam also nach und nach die Fauna Europas während der Tertiärzeit ein teilweise anderes Aussehen. Viele Gattungen wanderten besonders aus Südwestasien ein, die früher fehlten. Noch zur Oligozänzeit war Nord-europa von dem ganz zerrissenen Mittel- und Südeuropa durch ein breites Mittelmeer getrennt. Seit der jüngeren Miozänzeit zogen sich die Meeresteile und Meere allmählich zurück. Die kontinentale Verbindung der Balkanhalbinsel mit Kleinasien hatte die Einwanderung zahlreicher westasiatischer Gattungen im Gefolge. Manche derselben wanderten bis Mittel- und Nordeuropa, andere blieben in Südeuropa und breiteten sich hier aus; sie zogen bis zu den Säulen des Herkules und breiteten sich auch über die Länder des nördlichen Afrika aus. Dies wurde den Tieren um so leichter, da die Landmassen in Südeuropa mehr und mehr zusammenrückten und auch mit Nordafrika sich verbanden. Italien tauchte zur Miozänzeit aus der Wasserbedeckung auf. Sicilien trat dann mit Süditalien, ein breiter Landstreifen Nordafrikas mit Sicilien, Mittel-Italien mit dem mittleren Teile der Balkanhalbinsel in Verbindung. Sardinien und Korsika waren bis zur Pliozänzeit mit Italien durch Festland verbunden. Während der Pleistozänzeit wurden diese Landbrücken wieder unterbrochen. Hier also haben wir den Schlüssel zu den sonst weniger leicht zu erklärenden Diskordanzen in der Verbreitung von Gattungen und Arten. Gerade nach Südeuropa wanderten zahlreiche Gattungen aus Westasien ein, besonders viele Tenebrioniden: die vielen Arten von *Pimelia*, *Akis*, *Erodius*, *Pachychila*, *Tentyria*, *Stenosis*, *Dichillus*, *Blaps*, *Adesmia*, *Dendarus*, *Pedinus*, *Heliopates*, *Micrositus*, *Opatrum*, u.s.w.;—dann *Gymnopleurus*, *Scarabæus*, *Onitis*, *Chironitis*, *Homaloplia*, *Rhizotrogus*, *Amphimallus*, *Geotrogus*, *Anoxia*, *Melolontha*, *Elaphocera*, *Anisoplia*, *Pentodon*, *Cetonia*, u.s.w. Auch manche Carabidengattungen: *Aristus*, *Ditomus*, *Acinopus*, *Dichirotrichus*, u.s.w. Diese westasiatischen Gattungen wanderten während der letzten Perioden der Tertiärzeit in Europa ein. Alle diese Gattungen fehlen in Nordamerika; sie gehören einem eigenen Entwicklungszentrum in West- und Centralasien an. Nicht so gewisse andere Gattungen, welche wir noch werden kennen lernen, z. B. *Asida*, Verwandte von *Scaurus*, ferner *Amphicoma*, *Cebrio*, u.a.

Jene Gattungen aber, welche aus Westasien einwanderten und Südeuropa und die nordafrikanischen Mediterranländer besiedelten, sind ein ausserordentlich formenreiches paläarktisches Element in diesem Gebiet, zumal in Nordafrika, gleich verschiedenen Säugetieren (*Ursus*, *Cervus*, *Ovis tragelaphus*, etc.), die im übrigen, durch das breite Saharameer abgetrennten Afrika völlig fehlen.

Das alttertiäre Element Europas.

Während gewisse altertümliche Coleopterengruppen sicher aus dem mesozoischen Zeitalter stammen, ist die Entstehung anderer Gruppen für die ältere Tertiärzeit anzunehmen. Diese Annahme kongruirt vorzüglich mit gewissen geologischen Befunden aus dem Bereiche fossiler Mammalien des Alttertiärs Europas und Nordamerikas. Darnach ist eine typische Gleichartigkeit der terrestrischen Mammalien des Eocäns Europas mit denjenigen Nordamerikas eine der auffallendsten paläontologischen Erscheinungen (ZITTEL). Die nördliche Kontinentalbrücke zwischen Nordamerika und Nordwest-Europa bot gewiss einen breiten Raum zum Austausch der Tierwelt. Die leitenden eocänen Gattungstypen der Mammalien Nordamerikas sind dieselben wie im Eocän Europas: *Coryphodon*, *Hyracotherium*, *Pachynolophus*, *Phenacodus*, *Protogonia*, *Calomodon*, etc. Die Gattungen der damaligen Säugetiere sind die Vorläufer verschiedener Gruppen, die erst später differenziert wurden. In der darauf folgenden Oligocänepoche ist bereits eine Sonderung zwischen den nordamerikanischen und europäischen Mammalien bemerkbar. Die Differenzierung derselben wird in der demnächstigen Miozänzeit grösser. Die nordatlantische Landverbindung wurde offenbar immer kleiner, ragte aber wohl noch in die Miocänzeit hinein. Während der Eocän- und Oligocänzeit, den ältesten Epochen der Tertiärperiode, als die oben genannten Säugetiergattungen in gleicher Weise Europa und Nordamerika bevölkerten, müssen auch die übrigen Tiere an dieser Verbreitung teilgenommen haben. Sie wurden seit jenen warmen Zeitepochen sicher weiter nach Süden gedrängt, können aber in Südeuropa und Afrika noch passende Existenzbedingungen gefunden haben. So erkläre ich mir für die Nordhemisphaere

die Beschränkung der zahlreichen Arten von *Asida*, einer Gattung der Tenebrioniden auf das mediterraneische Gebiet und das wärmere Nordamerika. Eine Erklärung dieser merkwürdigen zoogeographischen Tatsache ist wohl niemals versucht worden. Wir sehen aber, dass die vorstehende Erklärung für ganz plausibel zu halten ist. Diese Erdkäfer sind noch jetzt sehr artenreich; wir kennen aus Südeuropa mehr als 120 Arten, welche über Spanien-Portugal, die Balearen, Südfrankreich, Corsica, Sardinien, Sicilien, Italien, Süd-Tirol, Dalmatien, Süd-Ungarn, Montenegro, Taurien, Griechenland und Kleinasien verbreitet sind. Nur eine Art, *Asida sabulosa* Goeze (*grisea* Oliv.) findet sich auch in der preussischen Rheinprovinz, also ziemlich nördlich, und zwar nach BACH und BERTKAU bei Boppard, Coblenz, am Laacher See und bei Hönningen zwischen Bonn und Coblenz. Die Rheinprovinz ist die einzige Fundstelle dieser Art nördlich von den Alpen. Sonst bewohnt sie Südfrankreich, Italien, die Süd-Schweiz, Süd-Tirol, u.s.w. Da die Gattung *Asida* nach meinem Dafürhalten über eine nördliche Kontinentalbrücke sich über Nordamerika und Europa verbreitet hat, so folgt daraus, dass die einzige deutsche Spezies in der Rheinprovinz als tertiärzeitliches Relikt sich noch bis in die Jetztzeit erhalten hat. Die günstigen klimatischen Verhältnisse des Rheintales sind wohl die Ursache dieser Konservierung.—*Asida* gehört also zu dem alttertiären Element Europas. Die Gattung *Asida* bewohnt in 50 Arten auch Nordafrika, von Marokko bis Aegypten. Auch aus Südafrika sind etwa 20 Arten bekannt, die von dieser Gattung sich kaum unterscheiden. Dass aber *Asida* auch über Teile Nordamerikas verbreitet ist, erscheint, wie oben gesagt, höchst merkwürdig; sie findet sich dort in mehr als 40 Arten in Californien, Utah, Oregon, Nevada, Kansas, Arizona, und Neu-Mexiko, und ausserdem in 48 Arten in Mexiko, von denen einige Arten auch in den südlichen Vereinigten Staaten leben. Ausserdem giebt es in Mexiko noch eine Anzahl nahe mit *Asida* nahe verwandte Gattungen, die alle zu den Asidinen gehören.

Ganz ähnlich verhalten sich auch die Scaurinen, eine andere Gruppe der Tenebrioniden, *Scaurus* ist in Europa mit 37 Arten auf das mediterraneische Gebiet (Südeuropa-Nordafrika) be-

schränkt, *Cephalostenus* mit 3 Arten. Ausserdem giebt es noch in Südafrika 2 Scaurinigattungen, *Herpiscius* und *Carchares*. Die amerikanischen Scaurinen gehören zu den Gattungen *Argoporis*, *Cerenopus* und *Eulabis* mit zusammen 25 Spezies, welche Californien, Oregon, Arizona, Texas und Mexiko bewohnen.

Es ist demgegenüber merkwürdig, dass einige gattungs- und artenreiche Gruppen der Tenebrioniden, welche gleichfalls über das mediterraneische Gebiet formenreich verbreitet sind, nämlich die Adesmiinen, Erodiinen, Acisinen, Stenosinen, Blaptinen und Pimeliinen, in Nordamerika nicht vertreten sind, hier vollständig fehlen. Diese Gruppen sind aber, im Gegensatz zu den Asidinen und Scaurinen, bis Central-Asien und noch weiter verbreitet, teilweise bis Indien und über Afrika. Während der älteren Tertiärzeit lebten die Gattungen dieser sechs Gruppen noch nicht so in Europa neben den beiden anderen Gruppen wie jetzt; sie sind erst später von Asien her eingewandert, und zwar erst dann, als die Kontinentalbrücke im Nordatlantik verschwand oder verschwunden war. Während der Eozän- und Oligozänzeit waren die einzelnen Teile des Mediterraneums von Asien getrennt, während der Miozänzeit war Südeuropa schon besser entwickelt, umfangreicher und durch einen breiten Kontinentalstreifen mit Südwest-Asien verbunden (Karte von DE LAPPARENT). Wir sehen dabei zugleich, um welche Zeit die südwestasiatischen Coleopteren grossenteils in Europa einwanderten. Die vorstehend mitgeteilten Kongruenzen sind eine wesentliche Stütze für meine Deutung der zoogeographischen Verbreitung der genannten Tenebrionidengruppen. Jedenfalls ist hier der Versuch gemacht, die auffallenden Verschiedenheiten in der Verbreitung dieser Gattungsgruppen, teils ihr Vorkommen in Europa und Nordamerika, teils ihr Fehlen in letzterem Erdteil zu erklären. Die mitgeteilten geologischen Kongruenzen und zoogeographischen Tatsachen sind eine Gewähr für die Wahrscheinlichkeit der von mir mitgeteilten Theorie.

Uebrigens sind die mitgeteilten Beispiele nicht erschöpft. Die interessante Gruppe der Glaphyrinen, welche gewisse morphologische Charaktere der primitiven Scarabaeiden mit denen der Cetoniinen und Melolonthinen vereinigt und auch durch ihre Verbreitung einen archaistischen Stempel trägt, hat

ebenfalls eine so auffallende Verbreitung wie die Asidinen und Scaurinen. Sie bewohnt in Europa nur das Mediterraneum und einen Teil Central-Asiens, nämlich in 3 Gattungen (*Glaphyrus*, *Amphicoma*, *Anthypna*) Süd-Spanien, Italien, Süd-Tirol, Griechenland, die Ionischen Inseln, die Türkei, Rumelien, Kreta, Süd-Russland,—Kaukasus, Kleinasien, Armenien, Persien, Transkaspien, Buchara, Turkestan, Ost-Turkestan, Südwest-Sibirien, Mesopotamien, Syrien, Palaestina,—Aegypten, Tripolis, Tunis, Algerien, Marokko.—Dies ist an sich keine absonderliche Verbreitung; zahlreiche Gattungen sind ebenso oder ähnlich verbreitet. Bemerkenswert ist nur das merkwürdige Vorkommen von *Amphicoma* in Nordamerika, wo sie in 5 Arten das kalifornische Gebiet (Kalifornien, Nevada, Oregon) und östlich die Gegend von New-York und Massachusetts in 2 Arten bewohnt. Diese nord-amerikanischen Glaphyrinen wurden früher auf 2 besondere Gattungen, *Lichnanthe* und *Dasydera* verteilt; sie stehen aber der Gattung *Amphicoma* des mediterranen Gebietes so nahe, dass sie mit dieser Gattung verbunden werden müssen (s. *Cat. d. Glaphyr.* von ARROW). Die diskontinuierliche Verbreitung dieser Gattung ist also sehr auffallend. Wie sollen wir dieses biogeographische Bild erklären? Wie sollen wir uns den ursprünglichen Zusammenhang dieser jetzt getrennten Amphicomidenbezirke vorstellen? Es ist wohl kaum anders möglich als durch die bei *Asida* und den Scaurinen gegebene Deutung. Also gehört auch *Amphicoma* zu dem alttertiären Element Europas. Die übrigen Gattungen der Glaphyrinen werden uns an anderer Stelle beschäftigen. Die italienische *Anthypna* hat mit je 1 Art auch Gattungs-genossen in Japan und China (Yunnan). Eine zweite Gattung, *Toxocerus*, bewohnt China in 7 Arten und Tonkin in 1 Art. In Chile und Peru leben noch 3 andere Gattungen.

Dass die obige Erklärung der geographischen Verbreitung von *Asida*, der Scaurinen und Glaphyrinen wohl richtig und auf die erwähnten geologischen Vorgänge zurückzuführen ist, wird immer wahrscheinlicher. Auch die Gattung *Cebrio*, die Hauptgattung der Cebriiden, tritt dafür ein. *Cebrio* bewohnt einerseits das Mediterraneum, andererseits Nordamerika (Neu-Mexico, Texas, etc.). Die sehr nahe verwandte Gattung *Scaptolenus* bewohnt in 32 Arten Californien, Texas,

Mexico, Central-Amerika, und Südamerika. Es giebt noch einige andere Gattungen der Cebrioniden in Süd- und Ostasien, Nord- und Südafrika, Brasilien und Florida.

Ein eigentümliches Element ist *Nomius pygmæus* Dj., der monotypische Vertreter einer selbständigen Gruppe der Carabiden. Diese Art ist über Südeuropa (Südfrankreich, Sardinien, Ungarn, Griechenland), Nordafrika (Algerien), und Nordamerika (Georgien bis Californien und Lake Superior) verbreitet und mag gleichfalls, wie die vorstehend geschilderten Gattungen, betrachtet werden.

Das gilt auch von der gleichfalls zu den Carabiden gehörigen Gattung *Atranus*. *A. collaris* Mén. bewohnt Süd-Frankreich, Nord-Italien, Oesterreich und Süd-Ungarn,—*A. pubescens* Dej. Nordamerika.

Timarcha ist eine hauptsächlich mediterraneische Gattung der Chrysomeliden. Einige Arten bewohnen auch Mittel-Europa. Keine Art findet sich in Sibirien. Aber in Kalifornien, auf den Rocky Mountains, in Oregon und Britisch-Columbien finden sich 1 oder 2 Arten dieser Gattung. Auch diese Gattung trägt die Anzeichen eines alttertiären Elements an sich; es stammt wohl aus der Zeit der alttertiären nordatlantischen Kontinentalverbindung.

Es ist noch nicht leicht, sich ein Bild von der übrigen alttertiären Coleopterenfauna Europas zu machen. Die fossilen Gattungen sind dazu heranzuziehen. Die Gattung *Calosoma* war in Mittel-Europa während der mittleren Tertiärzeit formenreicher als jetzt. Die Arten waren teils den rezenten Arten Nordamerikas, teils Westasiens verwandt. Das ist eine Parallele zu jenen alttertiären Gattungen *Asida*, *Glaphyrus*, etc., mit dem Unterschiede, dass die nordamerikanischen *Calosoma*-Arten jetzt in Europa nicht mehr existieren. Das mag mit vielen anderen Gattungen auch der Fall. So z. B. war die Gattung *Cupes* (Vertreter einer archaistischen Familie der Coleopteren) während der Oligozänzeit in Mittel-Europa in einigen Arten vertreten (Bernstein Ostpreussens). Jetzt ist die Gattung mit einigen Arten auf Nordamerika und Ostasien beschränkt, in Europa ausgestorben. So mögen viele alttertiäre Gattungen Europas, die hier jetzt nicht mehr sind, in Nordamerika noch fortleben. Die Gattung *Carabus* sagt uns das

nicht; die wenigen nordamerikanischen Arten lassen sich auf eurasiatische oder europäische Formen zurückführen. Andere europäische Artengruppen von *Carabus* sind wohl erst während der mittleren Tertiärzeit in Mittel- und Südeuropa entstanden (nicht von ausserhalb eingewandert, da sie in Europa endemisch sind) z. B. die Artengruppen *Chrysocarabus*, *Chaetocarabus*, *Hygrocarabus*, *Cechenus*, *Platychrus*, *Hadrocarabus*, *Ctenocarabus*, *Plectes*, *Pseudocechenus*, *Mesocarabus*, *Archicarabus*, *Autocarabus*, etc. Manche dieser Artengruppen und manche einzelne Arten machen einen ganz relikttärenden Eindruck und sind in Wirklichkeit tertiäre Relikte. Sie sind, wie auch manche Artengruppen anderer Gattungen, aus der mittleren Tertiärzeit herzuleiten.

Für die letzte Epoche der Tertiärperiode und die Pleistozänzeit nimmt SCHARFF (s. oben) eine nordatlantische Landverbindung Nordwesteuropas mit Nordamerika an, welche von der alttertiären Kontinentalbrücke im nordatlantischen Ozean zu unterscheiden ist.

Das mesozoische Element in der Fauna Europas.

Wir können uns von der känozoischen (tertiär- und quartärzeitlichen) Coleopterenfauna Europas ein ungefähres, natürlich lückenhaftes Bild machen und die alten Elemente in der rezenten Fauna daraus zu excerpieren versuchen. Schwieriger und weniger verlässlich ist es, die viel älteren mesozoischen Elemente festzustellen. Ich glaube aber gewisse Grundlagen, eine feste Basis für die Feststellung mesozoischer Gattungen gefunden zu haben; denn mit leeren Vermutungen operiere ich nicht gern.

Typen der verschiedensten Familien der Coleopteren sind übrigens schon in den ältesten Schichten des Mesozoikums Mittel-Europas gefunden. Nach O. HEER, BRODIE, GIEBEL und Geinitz gehören die im Lias Europas (Schweiz, Mecklenburg, England) gefundenen Reste zu den Carabiden, Gyriniden, Scarabäiden, Cyphoniden, Elateriden, Buprestiden, Byrrhiden, Hydrophiliden, Parniden, Nitiduliden, Cryptophagiden, Mycetophagiden, Lathridiiden, Trogositiden, Cisteliden, Chrysomeliden und Curculioniden. Nach HANDLIRSCH ist die Familienzuge-

hörigkeit der mesozoischen Coleopteren, besonders derjenigen der Trias und Lias, nicht festzustellen. Das ist vielleicht zu weit gegangen.

Ob jedoch die als Curculioniden angesprochenen Fossilien wirklich alle zu den Rhynchophoren gehören, ist deswegen zweifelhaft, weil morphologisch ähnlich gebildete, also mit einem Rostrum versehene Coleopteren, auch in anderen Familien auftreten. Solche rostrate Coleopterenformen anderer Coleopterenfamilien dürfen nur als morphologische Vorläufer oder als Konvergenzerscheinungen aufgefasst werden. Derartige rostrate Gattungen finden sich in der Heteromerenabteilung bei den Salpinginen (*Salpingus*, *Rhinosimus*, etc.) und Mycterinen (*Mycterus*). Sogar bei den primitiven Malacodermaten (*Lycus*, *Dictyopterus*, *Porrostoma*) kommt ein Rostrum vor; ebenso bei einigen Cerambycidengattungen (*Rhinophthalmus* in der Gruppe der Lepturinen, sowie bei den Uracanthinen und Rhinotraginen).

Rostrate Coleopteren in fossilem Zustande sind also nur unsicher als Rhynchophoren zu deuten, wenn nicht noch andere Merkmale die Zugehörigkeit zu diesem Familienkreise bekräftigen. Und das ist bei fossilen Coleopteren, besonders mesozoischen, wegen der schlechten Konservierung gewöhnlich nicht der Fall.

Es scheint jedoch, dass eine Anzahl Familientypen unter den Coleopterenresten aus den Trias-, Lias- und Jura-Schichten anzunehmen ist.

Es giebt nun eine Anzahl Gattungen unter den Coleopteren, welche über alle oder die meisten Kontinente verbreitet oder wenigstens auf mehreren Kontinenten oder Inseln vertreten sind. Mindestens sind es Kollektivgattungen, wie ich sie gern bezeichne, z. B. *Carabus*, *Calosoma*, *Feronia*, die ausserordentlich weit verbreitet sind, und die bei den vielen partiellen Hebungen und Senkungen, Verbindungen und Trennungen der Kontinente und Kontinentteile von den ältesten mesozoischen Perioden an sich immer weiter verbreiten konnten. Mesozoische Gattungen konnten sich sowohl auf der Nordhemisphaere über die holarktischen Kontinente als auch auf der Südhemisphaere über die zeitweilig verbunden gewesenen antarktischen Kontinente verbreiten. Die Calosomen z. B. sind wohl auf diese Weise über alle Kontinente und grösseren Inseln (auch kleine Inseln) verbreitet. Wesentlich ist für die Verbreitung palä-

arktischer Gattungen der ehemalige Kontinent, der sich von Ostasien (Tian-schan, Ochotschkischer Meerbusen, Südost-Sibirien incl. Sachalin und Japan, China), über Hinter-Indien, Indonesien, Neu-Guinea, Neuholland bis Vandiemensland erstreckte (s. die NEUMAYR'SCHE Karte der Jura-Kontinente und Meere). Gattungen, die erst später, besonders in der Tertiärzeit auftreten, hatten keine Gelegenheit mehr, sich activ über alle Kontinente zu verbreiten.

Hiermit haben wir also eine Basis für die Feststellung der mesozoischen Gattungen Europas. Die passiv verbreiteten Arten sind vorsichtig auszuscheiden. Es ist sehr wahrscheinlich, dass im mesozoischen Zeitalter schon die hauptsächlichsten, vielleicht alle Familien der Coleopteren entstanden, mindestens als Kottektivgruppen vorbereitet waren. Wohl aus diesem Grunde sind Vertreter fast aller Familien in allen Kontinenten und Kontinentalinseln vorhanden.

Einen Maassstab für das mesozoische Alter der Insekten Neuhollands haben wir in der bekannten Fauna dieses Kontinents, dessen Mammalien (Beuteltiere, Schnabeltiere) einen ganz mesozoischen Charakter haben, und die sich besonders durch ihre primitive Natur auszeichnen.

Unter den Coleopterengattungen Neuhollands finden sich viele rezente europäische Gattungen, deren Verbreitung von Europa und Asien aus nach Australien wahrscheinlich während des mesozoischen Zeitalters, und zwar in der Jurazeit, stattfand. Europäische, auch in Australien vertretene Gattungen sind z. B. unter den Carabiden: *Tetracha*, *Cicindela*, *Calosoma*, *Carabus-Pamborus*, *Drypta*, *Polystichus*, *Zuphium*, *Pheropsophus*, *Cymindis*, *Demetrias*, *Dromius*, *Apotomus*, *Dyschirius*, *Clivina*, *Chlœnius*, *Oodes*, *Badister*, *Anisodactylus*, *Harpalus*, *Acupalpus*, *Stenolophus*, *Abacetus*, *Argutor*, *Feronia*, *Abax*, *Pœcilus*, *Platynus*, *Pogonus*, *Trechus*, *Tachyta*, *Tachys*, *Bembidium*;—Dytisciden: *Haliphus*, *Pelobius* (*Hydrachna*), *Hyphydrus*, *Bidessus*, *Hydroporus*, *Colymbetes*, *Copelatus*, *Laccophilus*, *Cybister*, *Eretes*, *Hydaticus*;—Gyriniden: *Gyrinus*;—Rhysodiden: *Rhysodes*;—Hydrophiliden: *Hydrophilus*, *Hydrobius*, *Philhydrus*, *Hydræna*, *Cyclonotum*, *Berosus*, *Hydrochus*, *Cercyon*;—Staphyliniden: *Silusa*, *Aleochara*, *Myrmedonia*, *Oxyopoda*, *Atheta*, *Phlœopora*, *Gyrophæna*, *Oligota*, *Cilex*, *Conurus*, *Quedius*, *Philonthus*,

Ocybus, *Cafius*, *Xantholinus*, *Lathrobium*, *Pæderus*, *Doliceon*, *Cryptobium*, *Stilicus*, *Scopæus*, *Lithocharis*, *Sunius*, *Ædichirus*, *Stenus*, *Bledius*, *Oxytelus*, *Omalium*;—Pselaphiden: *Ctenistes*, *Tyrus*, *Pselaphus*, *Tychus*, *Batrisus*, *Bryaxis*, *Bythinus*, *Euplectus*;—Scydmaeniden: *Scydmaenus*;—Silphiden: *Choleva*;—Trichopterygiden: *Ptilium*;—Scaphidiiden: *Scaphidium*, *Scaphisoma*;—Histeriden: *Hololepta*, *Platysoma*, *Paromalus*, *Epierus*, *Teretrius*, *Acritus*, *Saprinus*, *Gnathonus*, *Abraeus*, etc.;—Scarabæiden: *Bolboceras*, *Trox*;—Nitiduliden: *Brachypterus*, *Carpophilus*, *Nitidula*, *Cryptarcha*, *Soronia*, *Pocadius*, *Cychramus*;—Colydiiden: *Bothrideres*, *Ditoma*;—Cucujiden: *Cucujus*, *Brontes*;—Byrrhiden: *Limnichus*;—Georyssiden: *Georyssus*;—Dryopiden (Parniden): *Limnius*, *Elmis*;—Heteroceriden: *Heterocerus*, etc., etc.;—Cerambyciden: *Necydalis*, *Callidium*, *Clytus*, *Monohammus*, *Exocentrus*, *Oberea*;—Chrysomeliden: *Lema*, *Crioceris*, *Cryptoccephalus*, etc.;—Curculioniden: *Apion*, *Auletes*, *Lixus*, *Mylloceris*, *Erirhinus*, *Magdalis*, *Balaninus*, *Anthonomus*, *Orchestes*, *Elleschus*, *Tychius*, *Nanophyes*, *Cionus*, *Acalles*, *Baridius*, *Cossonus*, etc.—Auch unter den nicht aufgezählten Familien gibt es noch eurasiatische Genera in Australien. Es möchte die Ansicht sich geltend machen, dass die aufgezählten Gattungen nicht seit der Jurazeit (!) in Europa oder vielmehr Eurasien und Australien dieselben geblieben sein könnten, sondern dass sie sowohl hier auf der Nordhemisphaere, als auch weit drüben auf der Südhemisphaere während des unendlich langen Zeitraumes sich hätten differenzieren müssen. Das ist ebenfalls nur eine Meinung oder Behauptung ohne Beweise. Diese Gattungen können ja trotzdem identisch geblieben sein; denn wir wissen, dass aus noch viel entlegeneren Zeiträumen stammende Gattungen bis auf den heutigen Tag dieselben geblieben oder nur wenig verändert sind, z. B. die Zungenmuscheln (Linguliden) und die Terebrateln der kambrischen Periode und der Silurzeit. Derartige geologische Dauerformen giebt es noch mehr. *Pelobius*, eine tiefstehende Form der Dytisciden, die so diskontinuierlich verbreitet ist, dass man nur einzelne Spezies aus Europa, Tibet und Neuholland kennt, ist doch ohne Zweifel aus alter geologischer Zeit abzuleiten; ihre Verbreitung lässt keine andere Deutung zu. Und doch sind die Arten dieser alten Gattung einander sehr ähnlich. Was von dieser Gattung

gilt, lässt sich auch auf die übrigen anwenden. Ich führe besonders noch die Gattung *Omophron* an.

Wir haben noch manche kongruente Hinweise in manchen Gruppen und Gattungen. Die Verbreitung der Broscinen auf der Osthemisphäre passt vollkommen zu den geologischen Verhältnissen Eurasiens zu Ostasien und Australien während eines Zeitraumes im mesozoischen Zeitalter: der Jurazeit. Ich habe schon oben angeführt, dass um diese Zeit der ostasiatische Kontinent auch Neuholland umfasste und bis Vandiemensland reichte. Unter den vielen neuholländischen Broscinen giebt es manche Gattung, die der eurasiatischen Gattung *Broscus* sehr ähnlich ist. Also gehört auch diese Gattung zum mesozoischen Element Europas.

Ich komme also immer wieder auf denselben Gedanken und die gleiche Schlussfolgerung zurück, nämlich alle die vorstehend aufgeführten und teilweise näher beleuchteten europäischen oder vielmehr eurasiatischen Genera als zu einem mesozoischen Element gehörige Genera anzusprechen.

Das afrikanische Element in Europa.

Es giebt gewisse Gattungen, welche weit über Afrika verbreitet und artenreich sind, aber auch an der Fauna Europas teilnehmen. Dahin gehört vor allem die Curculionidengattung *Brachycerus*. Die Brachycerinen umfassen nur wenige Gattungen; sie haben in Südafrika ihr Verbreitungszentrum und sind von dort aus über Afrika, hauptsächlich Ostafrika verbreitet. Von den 5 unterschiedenen Gattungen leben 4 in Capland und in zunächst benachbarten Gegenden. Von diesen 4 Gattungen sind 3 auf das Capland beschränkt (*Protomantis*, *Theates*, *Euretus*). Von der vierten Gattung, *Brachycerus*, die nach dem neuesten Cataloge von BOVIE 292 Arten enthält, bewohnt die überwiegende Mehrheit Südafrika. Die wenigsten Arten finden sich in West- und Ostafrika, einige auf Madagaskar. Nur 19 bewohnen die paläarktische Fauna, besonders Nordafrika, nur 11 Arten Südeuropa bis West-Frankreich und Kaukasus. Eine Spezies (*porcellus*) Südeuropas (Balkan, Türkei, Kleinasien) ist als besondere Gattung *Herpes* unterschieden.

Eine andere Gattung des mediterranischen Gebietes, *Sepi-*

dium, stammt gleichfalls aus Afrika und ist wahrscheinlich erst spät eingewandert. Diese Gattung bewohnt Ost-, West- und Südwestafrika, den Sinai, Arabien, Nordafrika, und Südeuropa (Spanien, Sizilien, Sardinien, Griechenland), etwa in 45 Arten. Den Zusammenhang Nordafrikas mit Südeuropa deuten die Arten *Sepidium tricuspidatum* F. (Algier, Griechenland) und *barbarum* Sol. (Algier, Sicilien) an. Die übrigen 6 Gattungen der Sepidiinen bewohnen Afrika, hauptsächlich das intertropikale Afrika.

Gewisse andere über Afrika weit verbreitete Gattungen, nämlich *Anthia* und *Graphipterus* (Carabiden) sind zwar bis Nordafrika vorgedrungen, nicht aber bis Südeuropa.

Wenn *Brachycerus* und *Sepidium* schon während der letzten Epochen der Tertiärzeit nach Südeuropa gekommen sind, als Nordafrika noch an verschiedenen Stellen mit Spanien und Sicilien kontinental verbunden war, so mögen *Anthia* und *Graphipterus* erst nach der völligen Trennung Nordafrikas von Südeuropa während der Pleistozänzeit nach Nordafrika eingewandert sein.

Nach WERNER sind einzelne tropisch-afrikanische Orthopteren ebenfalls bis Nordafrika verbreitet, nämlich *Leptocala giraffa* bis Algerien, *Oxythespis senegalensis* in Tunis, *Idolomorpha* in Tunis.

Das afro-asiatische Element Europas.

Mehrere andere Gattungen, welche Afrika weit und breit bewohnen und auch Südeuropa besetzt haben, finden sich auch in einem grösseren Teile Asiens. Diese verdienen eine besondere Betrachtung, da sie teilweise wohl zu einer anderen Zeit und auf anderen Wegen, teilweise während derselben Zeit und auf den gleichen Wegen Südeuropa besiedelt haben. Dahin gehören z. B. *Siagona*, *Pheropsophus*, *Scarabæus*, *Sisyphus*, *Gymnopleurus*, *Onitis*. Wahrscheinlich kommt hier der Verbreitungsweg vom tropischen Afrika durch Südasien bis Indien und Indonesien in Betracht und die Verbreitung von Südwest-Asien nach Südeuropa und durch die mediterranischen Länder Nordafrikas.

Auch gewisse Tenebrionidengattungen Südeuropas gehören zu dem afro-asiatischen Element, z. B. *Zophosis*. Diese Gattung

bewohnt in *Europa* Spanien, Sizilien, Sardinien, Griechenland, Creta, Südrussland ; in *Asien* den Kaukasus, Armenien, Transkaspien, Turkestan, Persien, Syrien, Arabien, Sinai ; in *Nordafrika* Marokko, Algerien, Senegambien, Aegypten ; im *übrigen Afrika* Ostafrika von Abyssinien, Sokotra bis Natal, Capland, Südwest-Afrika, Angola. Auch auf Madagaskar, Teneriffa und den Canarien sind Arten gefunden.

Also auch dieses Element bietet noch Anregung zu weiteren Forschungen, die hier nur in einigen grösseren Zügen angedeutet sind.

Im vorstehenden sind die Elemente der Fauna Asiens und Europas im grossen Ganzen behandelt ; ihre Zahl ist gewiss nicht ganz erschöpft. Wir ersehen aber aus dem Mitgetheilten, wie mannigfaltig die Zusammensetzung dieses Faunengebietes aus einzelnen Elementen ist, je nach dem geologischen Alter oder nach der geographischen Herkunft. Erst mit Betrachtungen dieser Art wird das Verständnis für den Inhalt des Faunengebietes eines Kontinents gewonnen.

THE SIMULIUM-PELLAGRA PROBLEM IN ILLINOIS, U.S.A.

By STEPHEN A. FORBES, ILLINOIS.

THE advancement of entomology owes much, of recent years, to the stimulus supplied by the discoveries made by medical men with respect to the agency of insects in the transmission of contagious diseases; and just now our knowledge of the species, distribution, habits, life histories, and ecology of *Simulium* is progressing by leaps and bounds in consequence of the well-known *Simulium* theory of the transmission of pellagra, announced by Dr. LOUIS W. SAMBON in 1905, and fully elaborated by him in the *Journal of Tropical Medicine and Hygiene*, in 1910.

This stimulus to a study of these insects reached me, in one of the interior States of North America, in August 1910, when, in consequence of the appointment by the Governor of Illinois of a State commission for the investigation of pellagra as occurring in the insane asylums and other institutions of that State, I was requested, as the official Entomologist of Illinois, to contribute to their report an account of the distribution of *Simulium*, especially in the neighbourhood of State institutions in which cases of pellagra were occurring. As an investigation of all insects injurious or dangerous to the public health in Illinois is one of the prescribed duties of my office, I was bound to avail myself, to the best of my ability, of this opportune call. This I did by detailing an assistant, Mr. C. A. HART, August 8th, 1910, to commence observations and collections along the central part of the course of the Illinois River, and especially to make a careful survey of the vicinity of the General Hospital for the Insane, built upon a bluffy bank of that stream near the city of Peoria. My reason for giving particular attention to this asylum was the fact that it had been the principal seat of pellagra in Illinois, containing in 1909 80 per cent. of the cases of this

disease—that is 127 out of 220—recognised that year in the whole State. This bad pre-eminence has, in fact, been since maintained, this asylum containing 63 per cent. of the 408 cases known to occur in Illinois during the twenty-six months preceding the first of September 1911.

In the year 1911 but little could be done on this subject ; but beginning with April 1912, a continuous programme of observations, collections, and breeding-cage studies has been steadily maintained, and is still in progress on the Illinois River, and a careful survey has been made of the surroundings of the six insane hospitals of the State, and of the almshouse of the county in which the city of Chicago is situated. Cases of pellagra have occurred in all these institutions during the above-mentioned period, but in widely different ratios to the total number of inmates in each—the Peoria asylum, for example, containing, in 1909, twelve times as many cases per thousand inmates as did any other institution in the State. It thus became a matter of special interest to know the facts in detail concerning the occurrence and abundance of *Simulium* in the immediate neighbourhood and in the general vicinity of all these institutions.

Besides this work in the field, the insect collections of my office for many years have been carefully examined, and its field notes and accessions records have been sifted for evidence bearing on the species and distribution of *Simulium* in the State at large ; and the whole body of the American literature of the subject has been critically studied, with some reference also to a considerable list of European articles.

According to the present state of our knowledge there are approximately seventy species of *Simulium* on record for the whole world, of which we are known to have but fifteen in the United States of North America. Nine species, or possibly ten—the status of one being uncertain—have been found in Illinois, one of which, *S. hirtipes*, occurs also in Europe. No other European species has been found on the continent of North America, although *S. reptans* is reported from Greenland. The slight attention hitherto paid to these insects in America is illustrated by the fact that two of our nine Illinois species—or three of them, if there are ten in the State—are new to science,

the two known to be new having been described under the names of *venustoides* and *johannseni*.

As the State of Illinois extends, from north to south, through five and a half degrees of latitude, there is some difference between its most northern and its most southern districts in respect to the predominant species of *Simulium* ; but as all have similar habits, and all but one of them are active biters, this fact probably counts for little in the present discussion.

There is some difference also as to the kinds of waters in which the several species prefer to breed, some of them living mainly in the larger rivers, and others occurring only in the smaller streams ; but as the State is well watered in all its parts, and is virtually a level plain, there is no part of it which is wholly beyond the reach of some species of *Simulium*. It is true that these insects are rarely seen in some places, and are an annoying nuisance, and indeed a destructive pest in others, especially along the larger rivers in spring ; but since we have found them in considerable numbers at a distance of more than five English miles from the nearest water in which they could have bred, and since there is scarcely a small stream anywhere in some part of which *Simulium* larvæ cannot be found throughout the spring and summer, even temporary roadside drainage ditches often containing them during the spring season of high water, there must be few people in the State who are not at some time exposed to the attacks of the flies. *Simulium* is, in fact, more completely and uniformly distributed in Illinois than *Anopheles*, and as there is no part of the State wholly and permanently free from malarial disease, there would seem to be no part of it free from danger of pellagra, if this is really transmitted by black-flies.

The contrast is marked between these Illinois conditions and those in Italy, where Sambon and his colleagues studied the problem of pellagra and the distribution of the black-fly. There mountain heights, mountain valleys, and level plains make up a diversified topography and hydrography, and the distribution of *Simulium* is similarly diversified. It is one of the main lines of Sambon's argument that the distribution of pellagra is limited by the distribution of *Simulium*, although not co-extensive with it. This test cannot be verified in Illinois, however,

as *Simulium* is generally distributed. Pellagra, on the other hand, is intensely local, so far as is now known; but to this interesting point I shall presently return.

The life histories of the American species of *Simulium* are very imperfectly known, and the same may be said of those of all other parts of the world as well. No species, in fact, has been carefully followed, in its development, around the year, and on only two of our American black-flies, *venustum* and *pictipes*, has any kind of definite life-history work hitherto been done. Probably studies of this sort are now in progress in other places than Illinois, but if so their results have not yet been made known. In our own State we have gone far enough with this phase of our problem to make sure that six of our species, and possibly all of them, produce two or more generations in a season, and that there is a sufficient variation among the different species in respect to the times at which the successive generations emerge to make it certain that some *Simulium* species may be producing adults at every time of any average year, from early April to late October. We have, in fact, ourselves collected adults of one or more species, and have bred others, in each of these seven months, but much more frequently in April, May, and June than in any later ones.

The actual number of individuals on the wing, indeed, diminishes rapidly after the main spring outburst, so that it is usually difficult to find an adult *Simulium* in August or September, even in places made almost uninhabitable by them in April and May. This may be due in part to unknown features of the life history of two of the most prolific species, *pecuarum* and *meridionale*, but it is certainly due also, at least in part, to a summer shrinkage of the streams and a consequent reduction in the number of suitable places for the breeding of these discriminating insects. Whatever is the explanation, the fact itself is notorious, and it is of especial interest to our inquiry; for if *Simulium* transmits pellagra, there should be, generally speaking, some seasonal correspondence observable between this highly unequal abundance of the insect carriers of the disease and the number of new cases occurring.

There is, indeed, a very notable seasonal periodicity shown in Illinois in respect to the number of new cases of pellagra, but

it is not of the kind anticipated by this reasoning. My attention was first called to the facts last December by Dr. H. DOUGLAS SINGER, Director of the State Psychopathic Institute, at Kankakee. In the Peoria hospital, where the largest number of our cases have occurred, statistical data were obtainable from July 1st, 1909, to September 1st, 1911, and the curve showing the number of new cases in this hospital presents five notably high points, each the culmination of a wave of increase, in the period of two years and two months which it represents. In the first of these two waves the twenty-one new cases of July are followed by seventy-one in August, and this maximum by thirty-seven, twenty-three, twelve, and three for the months of September, October, November, and December respectively. In January 1910 there was but one new case; in February and March there were none; in April there was one; and with this a new wave started, reaching thirty-four new cases in June, dropping to but four in July, and rising in a second, lower wave of sixteen and fifteen in August and September respectively, dropping thence to one in October and none at all until February of the following year.

The largest number of new cases occurring in 1911 was only seven, in August, the next largest number coming in May, when there were six, and the two crests of these waves being separated by the low period of June and July with one and three cases respectively. In a word, the two annual high points come in either May or June of two of these years, and in August of three of them; while in the two years for which our records are virtually complete, the first wave is the highest in 1910, and the second is highest in 1911.

I believed at one time that we might make out a relation of succession between these separate waves of increase and the adult periods of successive generations of *Simulium*, but as my data accumulate this relationship becomes decidedly doubtful; and certainly these double pellagra periods cannot be connected with any seasonal differences in the *abundance* of *Simulium*. If there were any causal relation between these two facts there should be but one high pellagra period to correspond with the single spring outrush of *Simulium* adults; or if there were another it should be much lower than the first.

SAMBON reports a periodical character different from this observed in Illinois in the fact that it relates to an increased activity of pellagra—an intensification of its symptoms in individual pellagrins—occurring in spring and in fall, coincident, as he says, in Italy with the time of flight of two generations of the sand-flies ; and he uses this fact to support his hypothesis of the dependence of the disease on the insects. Assuming that pellagra is produced by a protozoan parasite, he further assumes that the aggravation of symptoms twice each year is due to a migration to the surface of this hypothetical parasite, which is thus exposed to be taken up by the sand-flies as they draw blood from the skin of pellagrins. The summer and fall recrudescences of the disease he thus connects with the summer and fall abundance of the sand-fly imagos. His periods are, however, different from ours, the first coming in March or April instead of May and June, and the second in September or October, instead of August as in Illinois. I have not been able to learn from our physicians that any periodicity similar to this described by SAMBON has been noticed in Illinois cases, but if it has it would be impossible to correlate it with the facts above described concerning the development of *Simulium* in our State.

There are other interesting points of contrast between our Illinois conditions and conclusions and those obtained by a study of the problem in Italy and in other parts of Europe. We are told, for example, that in Italy pellagra is a rural disease, to which town-dwellers are virtually immune, even where there is free communication between the town and adjacent pellagrous districts ; but in Illinois we have every year several deaths from pellagra in our largest city, with a population of more than two million souls. Four cases of this disease have lately been reported to me from the private practice of Dr. OLIVER S. ORMSBY, Secretary of the State Pellagra Commission, the sufferers from which had lived continuously in Chicago for years. Pellagra, in fact, can scarcely be said to be with us, as yet, a rural disease, the asylums in which 96 per cent. of the known new cases have occurred being in or very near cities and towns, and all cases reported from outside such institutions having come from the town and not from the country. The Peoria asylum, containing sixty-three of our known pellagrins, is in a

suburb of our second largest city. It draws its patients from all parts of the State, but more than a third of them come from Chicago or its immediate neighbourhood. Three other asylums, containing 30 per cent. more of our pellagrins, receive between 63 and 100 per cent. of their inmates from Chicago. The closest relations of these especially pellagrous asylums thus seem to be with our largest cities and not with our rural districts. These facts would be more certainly significant, however, if pellagra had been longer known and more thoroughly studied throughout our territory, and if we had complete and reliable statistics from the State at large.

Simulium is said in Italy not to live in towns or to enter houses; but in the town of Havana, a village of 3,600 inhabitants, situated on the Illinois River near the central part of my State, it is so great a pest in spring that the people screen their windows to protect themselves from the bites of the black-flies; and we have seen these insects collecting there in great numbers on the inside surfaces of the window-panes of public rooms, such as the offices of hotels. Furthermore, we have found biting species of *Simulium* breeding and emerging in large numbers, not only in the suburbs and outskirts of Chicago, but far within the limits of that great city—in the Chicago River, which traverses the city, passing through its most densely populated districts, and also in drainage ditches beside the streets when these happen to contain streams of running water for a sufficient time in spring. Indeed, it is not too much to say that *Simulium* may breed in any flowing stream within the city where the water is not offensively foul with sewage and other contaminations.

Reasoning from the time of the onset of pellagra in the case of certain infants born in November and in December, when sand-flies are not abroad in Italy, Dr. SAMBON comes to the conclusion that the incubation period in these cases could not have exceeded three weeks, this being the interval to elapse between the time when these infants were first carried out in spring to the fields where they might have been bitten, and the date of the appearance of the rash which was the first symptom of the disease. If this reasoning is sound, and these infantile cases are fair examples of the incubation period of pellagra, then I am troubled to explain the occurrence in Illinois of two asylum

cases—both reported as first attacks of the disease—one first manifest on December 24th, and the other on the 31st of that month, after a period of three or four weeks of severe cold weather. Our latest Illinois collections of *Simulium* adults made in any year were obtained November 5th, and these cases consequently seem to have developed some six or seven weeks after any possibility of infection by means of *Simulium* bites. It is possible, however, that this discrepancy is only apparent, and that these were not new cases, arising in the asylum, but recurrent attacks of a disease originating outside and not previously recognised.

Simulium does not require, with us, swift-running streams for its development, some of the species, at least, breeding in any freely flowing water where the surface is broken into a ripple by depending or projecting objects. A stout weed growing from the bottom of a stream near its margin, or a twig bending down and dipping into the water from the shore, or even a trailing grass blade, will in many cases be thickly covered—but only on the up-stream side—with the larvæ first, and afterward with the pupæ, of *Simulium*. We have even found larvæ and pupæ, both, in great abundance, coating objects on the bottom of the river at a distance from the shore and at a depth of nine or ten feet—a point in which our observations differ, so far as I know, from any others on record.

In Italy pellagra is said by SAMBON to be essentially a disease of mountain valleys; but if this rule applied in America, we should have only imported cases of pellagra in any part of Illinois, or indeed within hundreds of miles of its borders. There is, in fact, no common topographic feature distinguishing the three principal seats of pellagra in our State. The Peoria asylum, with 258 new cases in twenty-six months, is on a bluff about 150 feet in height beside one of our largest rivers; the Elgin asylum, with thirty-eight new cases in the same time, is on a more sloping bank, less than half as high, beside a much smaller stream; and the Dunning almshouse is on a level, open plain, with no water in its vicinity except a small drainage ditch, which often goes dry in midsummer. The country surrounding all these hospitals is a level or slightly rolling plain, originally covered with prairie grass except where streams were bordered with narrow belts of forest.

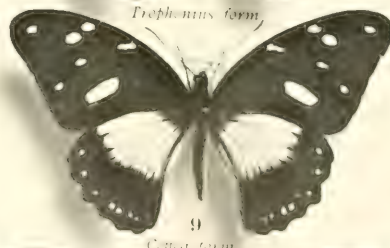
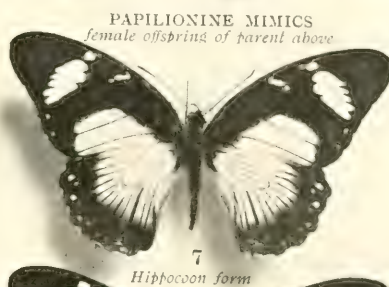
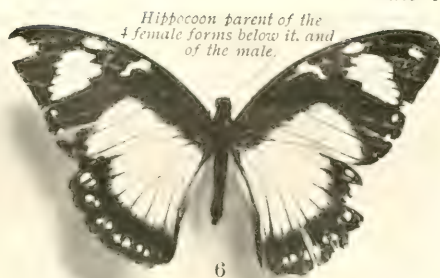
From the foregoing it will be seen that, although in this discussion I have been obliged to take a critical attitude towards the Simulium theory of this disease, our Illinois data are not, by themselves, plainly conclusive either for or against that hypothesis. This is a source of regret to me, although scarcely a disappointment, as one entomologist, working for so short a time and in so limited an area, could not expect to bring this time-worn and complicated problem to the point of actual solution; and I must be content with bringing forward my personal contribution of matters of fact to this important inquiry, of a kind to require that they be taken into account in forming an adequate theory of this disease. In the meantime, whether the Simulium theory be finally justified or not, it should be welcome to us, as I intimated in the beginning, as giving us motive and opportunity greatly to increase our knowledge of these interesting insects; and it is particularly for this reason that I have ventured to bring this imperfect discussion of a problem yet unsolved before this congress of the entomologists of the world.

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Alfred Robinson, photo

Nearly $\frac{2}{3}$ of the natural

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Papilio dardanus ceneia, the S. E. African Sub-species of *P. dardanus* with the four Danaïne models of its female forms. The proof by breeding that the mimics are one species (Near Durban, Natal, 1906, G. F. Leigh.)

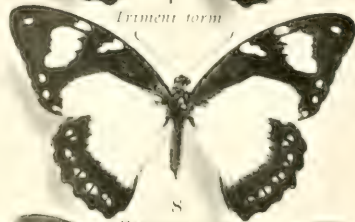
P. meriones, with non-mimetic female : Madagascar.



Escarpment near
Nairobi.



6 *Polytroplus* females of 4 forms.



Alfred Robinson, photo.

Illustration by the author (1910)

Andre & Stoll, 1911

The non-mimetic ancestor of *Papilio dardanus* (*merope*) from Madagascar, and transitional forms, shewing the origin of mimetic females, from the Kikuyu Escarpment, near Nairobi, British East Africa (6,500 -9,000 ft.)

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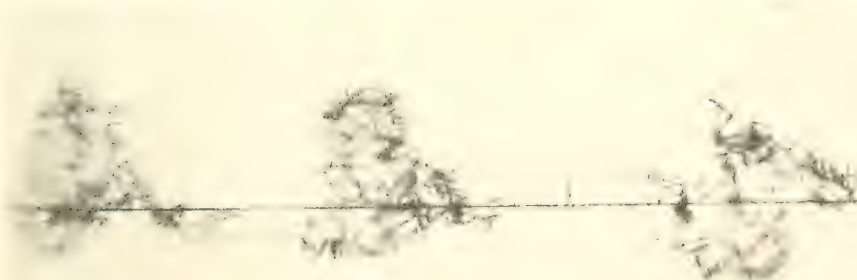
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COMSTOCK.—SILK OF SPIDERS.

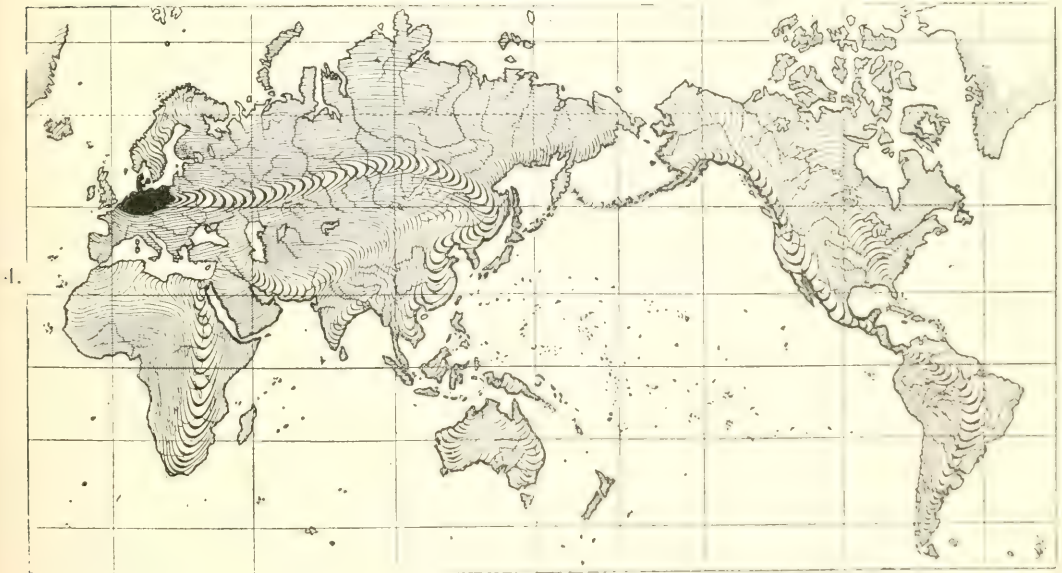
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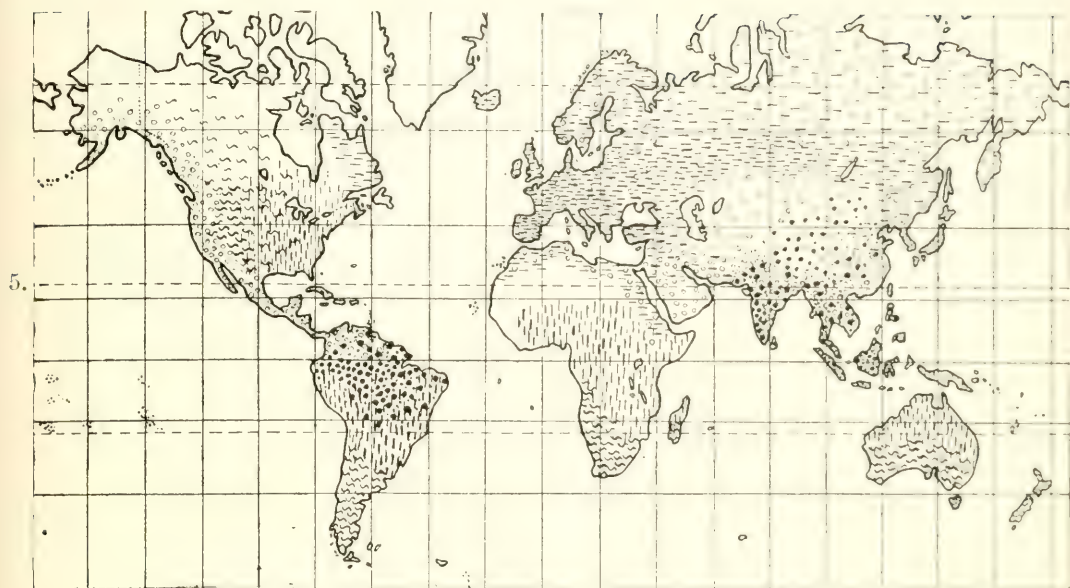


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TAYLOR.—GEOGR. DISTRIBUTION.





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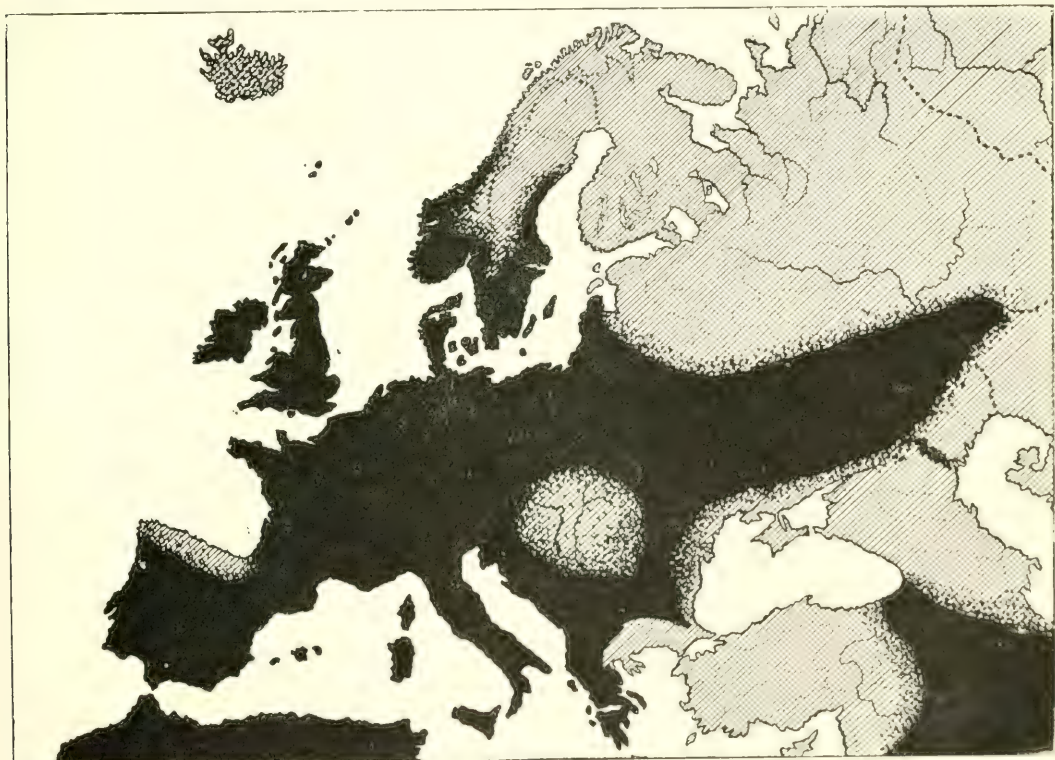
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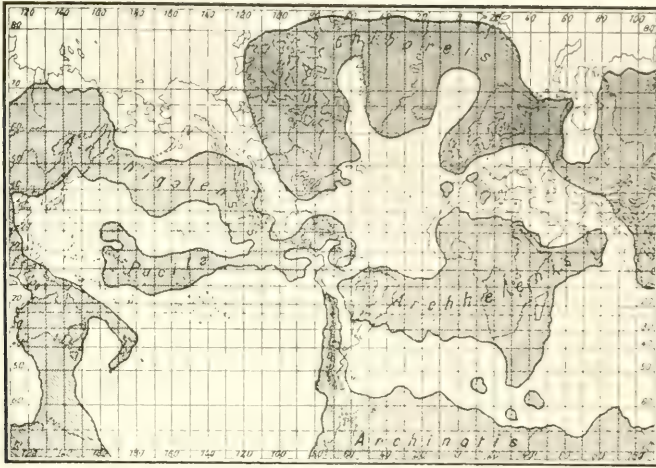
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TAYLOR.—GOEGR. DISTRIBUTION.



KARTE 1.—Zeigt die von H. v. IHERING für die Tertiärzeit angenommenen Kontinente.



KARTE 2.—Vermutliche Verteilung der Landgebiete vor dem Ende der Kreidezeit.



KARTE 3.—Vermutliche Verteilung der Landgebiete im Alttertiär.



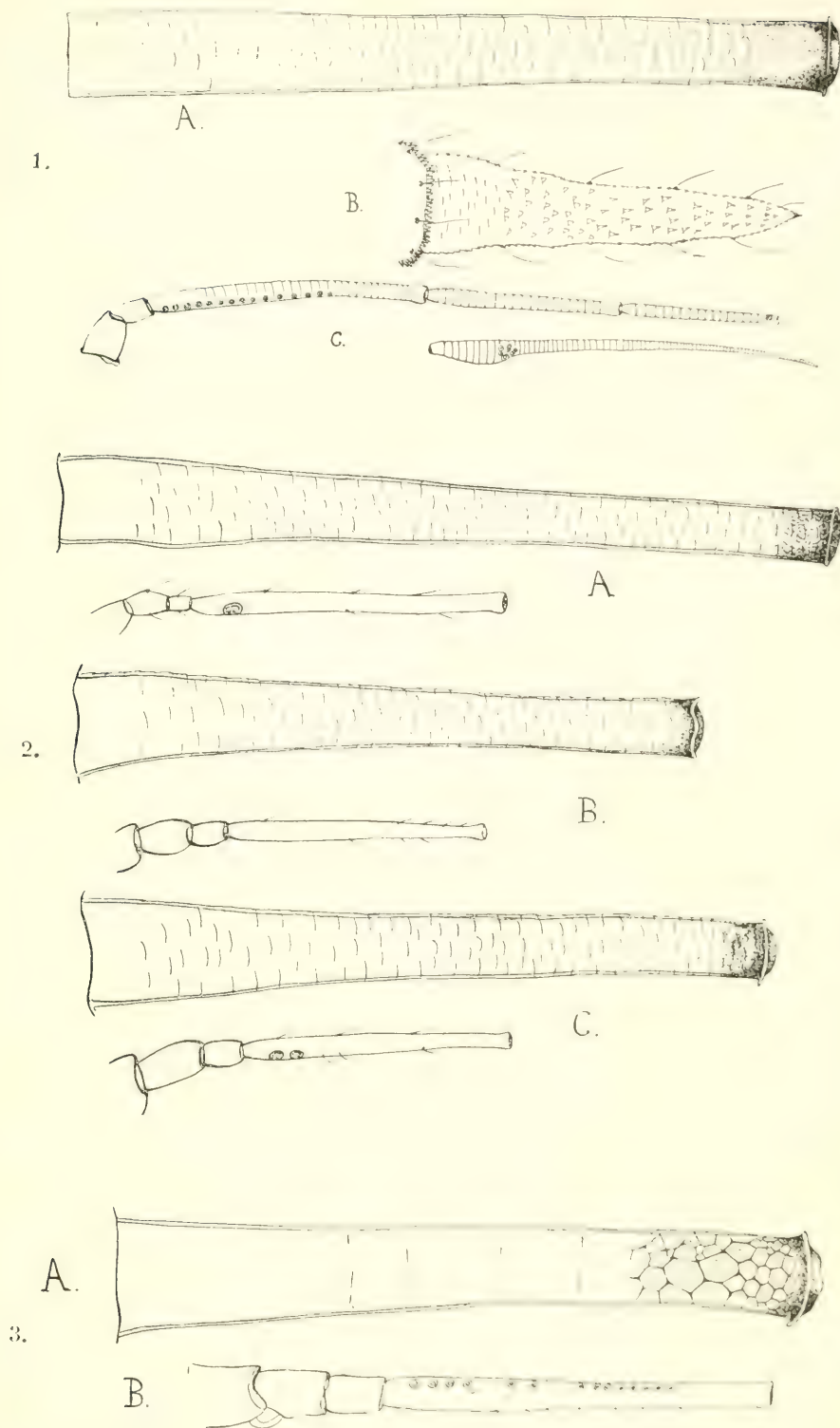
KARTE 4.—Vermutliche Verteilung der Landgebiete im Jungtertiär.

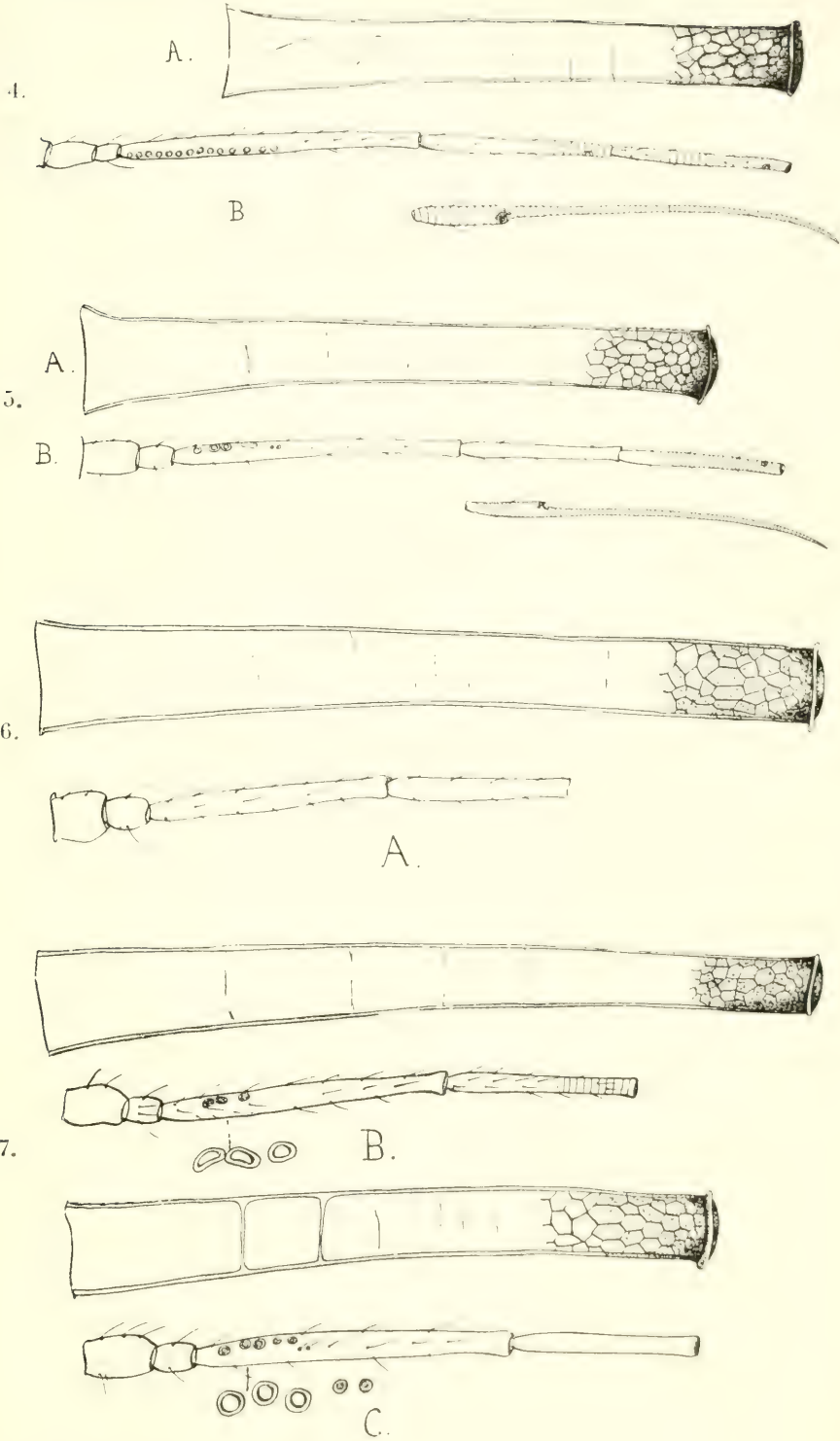


KARTE 5.—Gebiete diluvialer und gegenwärtiger Vereisung.



KARTE 6.—Die wichtigsten von verschiedenen Autoren angenommenen Landbrücken kombiniert.





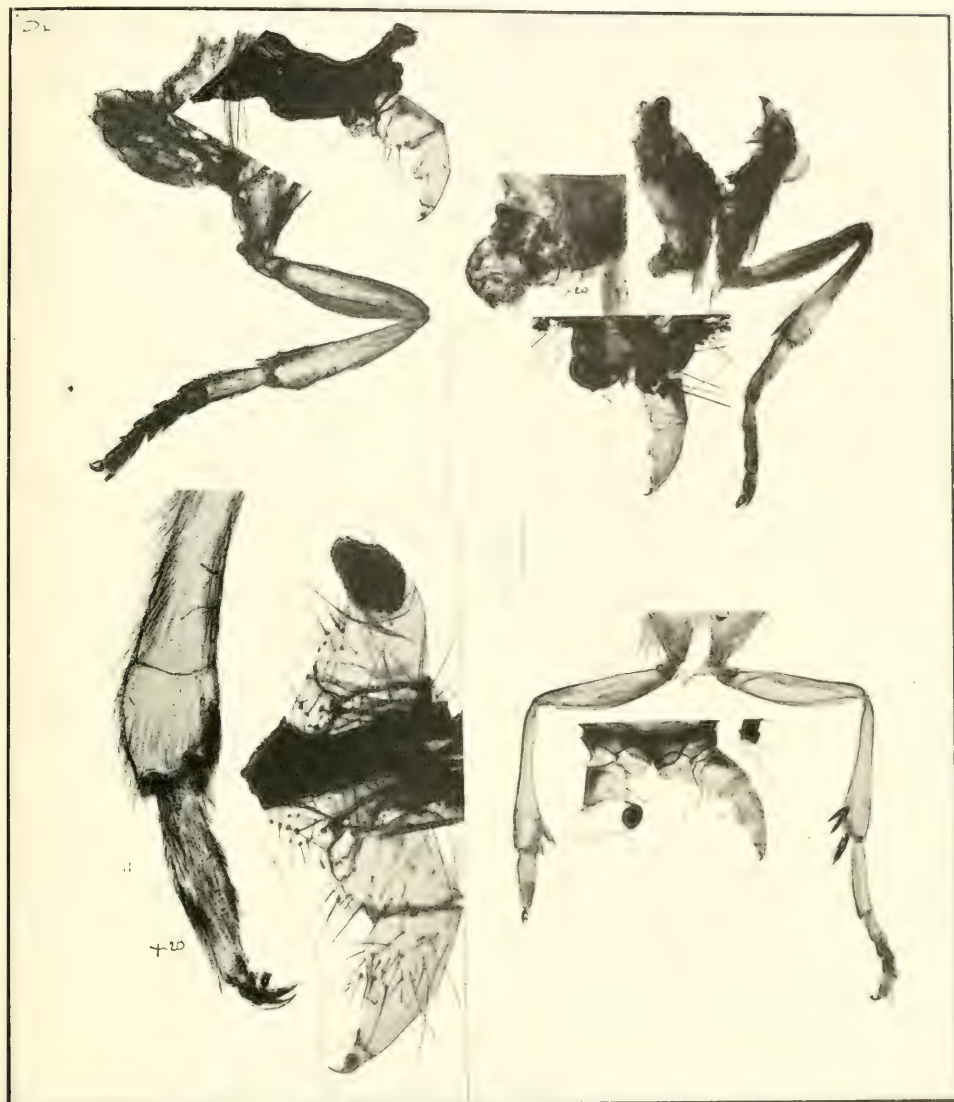


FIG. 1.—Complete amputation in last instar.
.. 2.—Basal amputation in last instar.
.. 3.—Tibial amputation in last instar.
.. 4.—Tibial amputation in last instar.

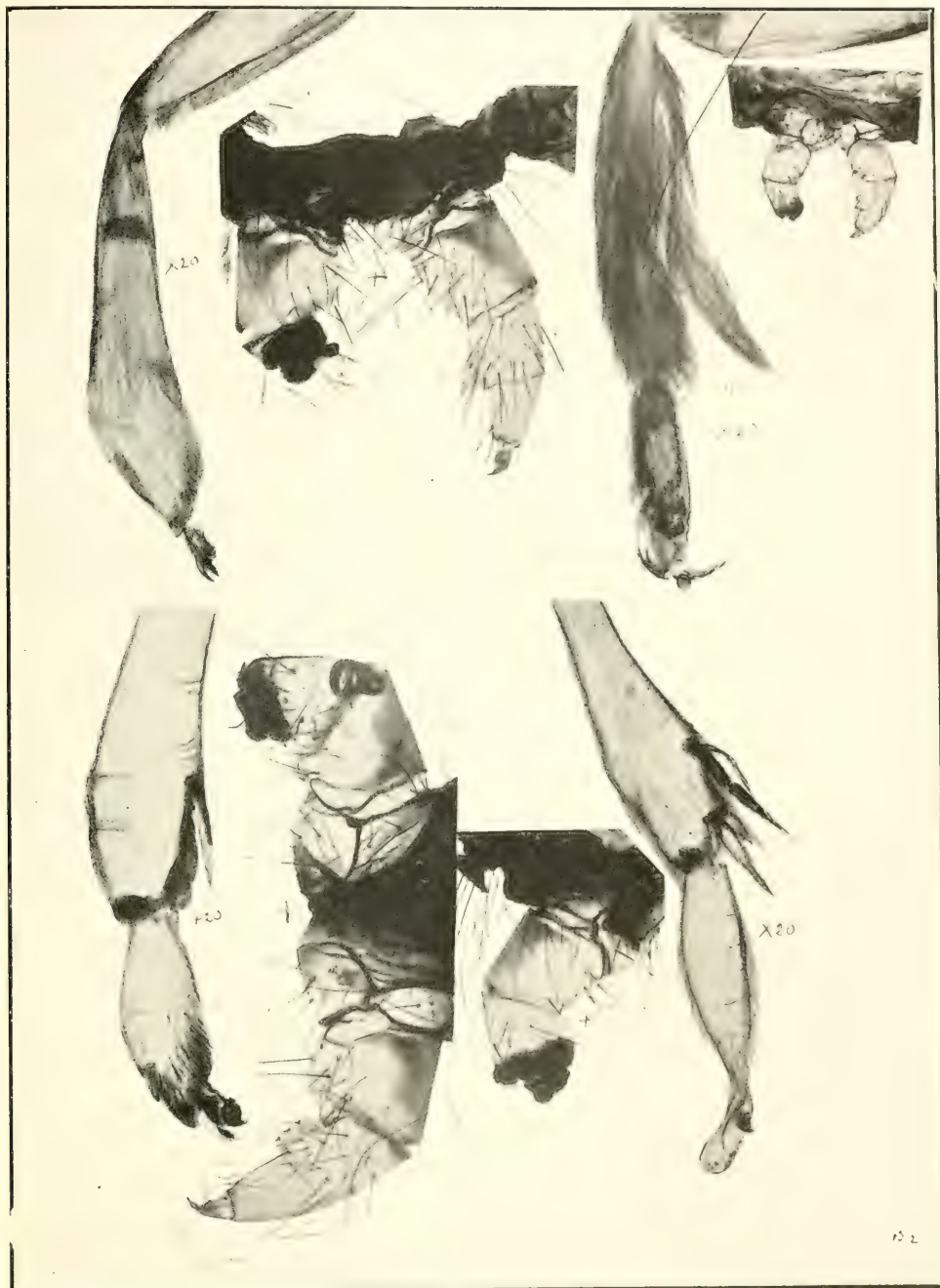


FIG. 5.—Tibial amputation in last instar.
 „ 6.—Tarsal amputation in last instar.
 „ 7.—Tarsal amputation in last instar.
 „ 8.—Tarsal amputation in last instar.

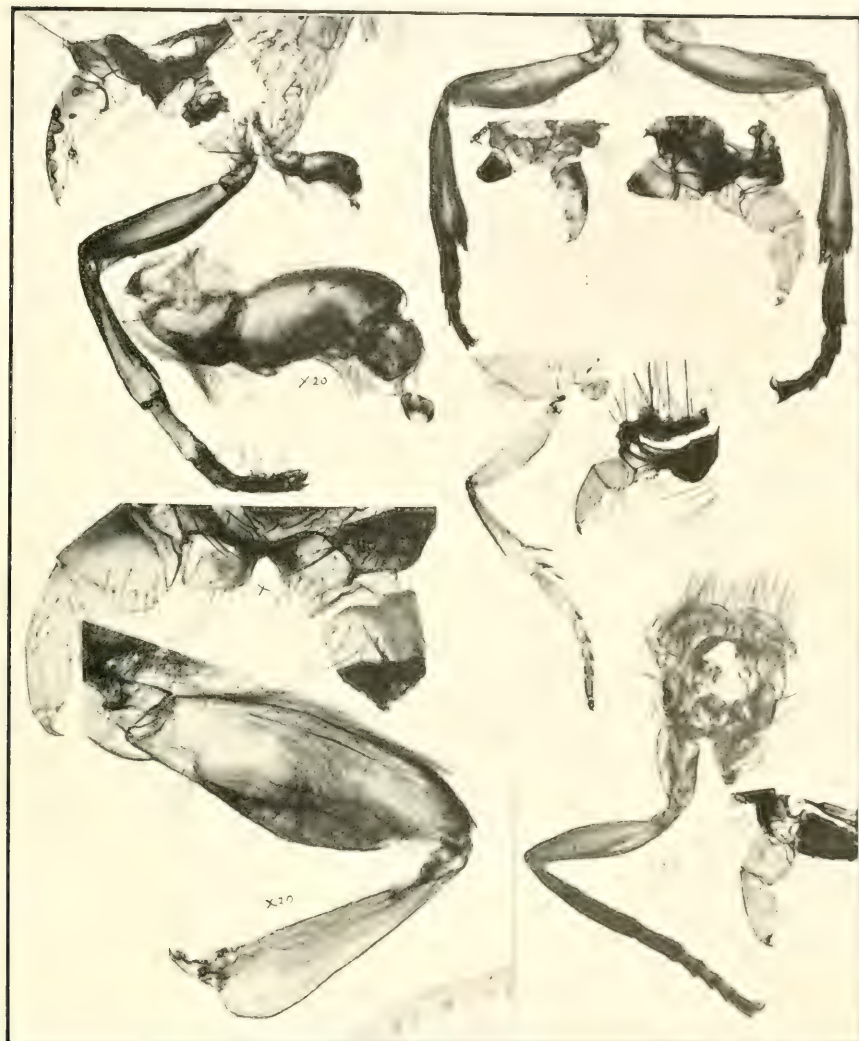


FIG. 9.—Femoral amputation in last instar.
,, 10.—Femoral amputation in penultimate instar.
,, 11.—Basal amputation in last instar.
,, 12.—Femoro-tibial amputation in last instar.
,, 13.—Basal amputation in last instar.

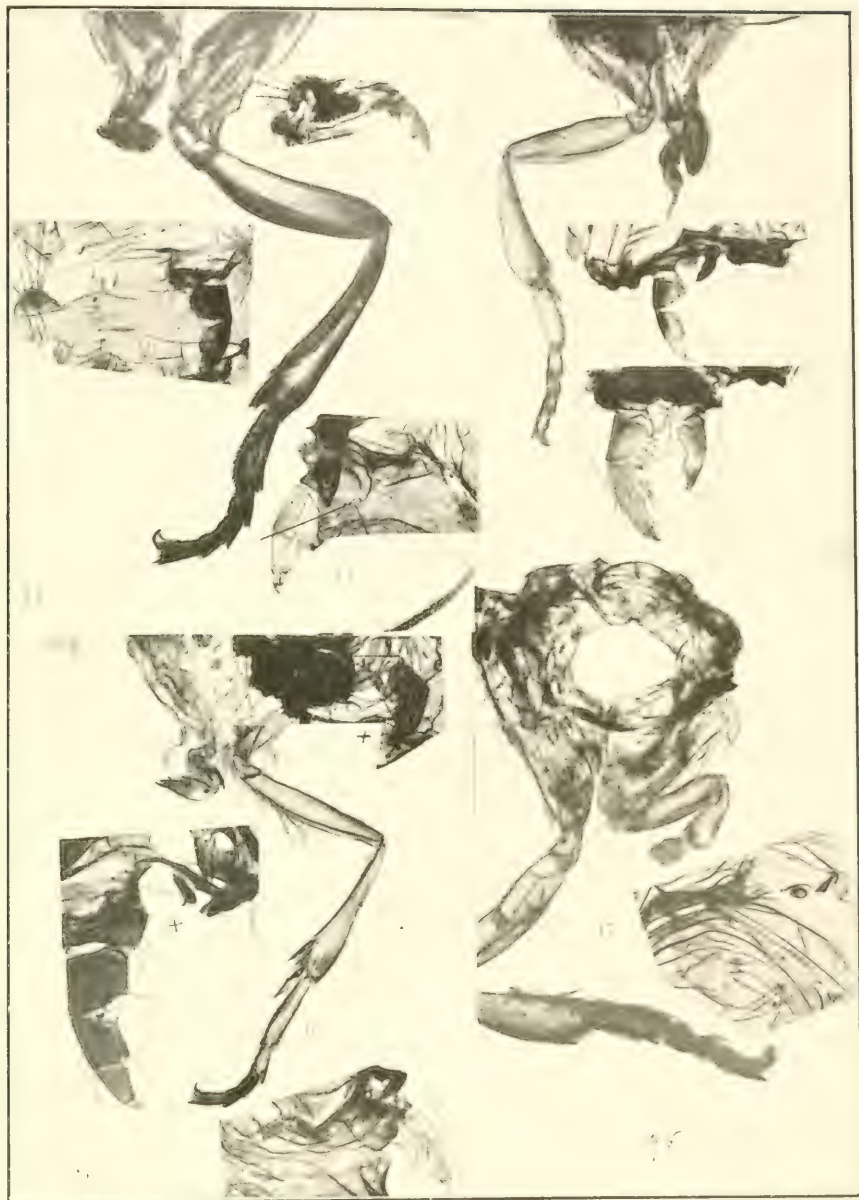


FIG. 14.—Complete amputation in 3rd instar.
.. 15.—Complete amputation in 3rd instar.
.. 16.—Complete amputation in 3rd instar.
.. 17.—Complete amputation in 4th instar.



FIG. 18.—Complete amputation in 3rd instar.
,, 19.—Complete amputation in 3rd instar.
,, 20.—Imperfect amputation in 3rd instar.
,, 21.—Amputation in base of femur in 4th instar.



FIG. 22.—Complete amputation in 4th instar.

„ 23.—Shows the tendency of claws to be developed and even duplicated when regeneration otherwise is very imperfect.

„ 24.—Complete amputation in 4th instar.

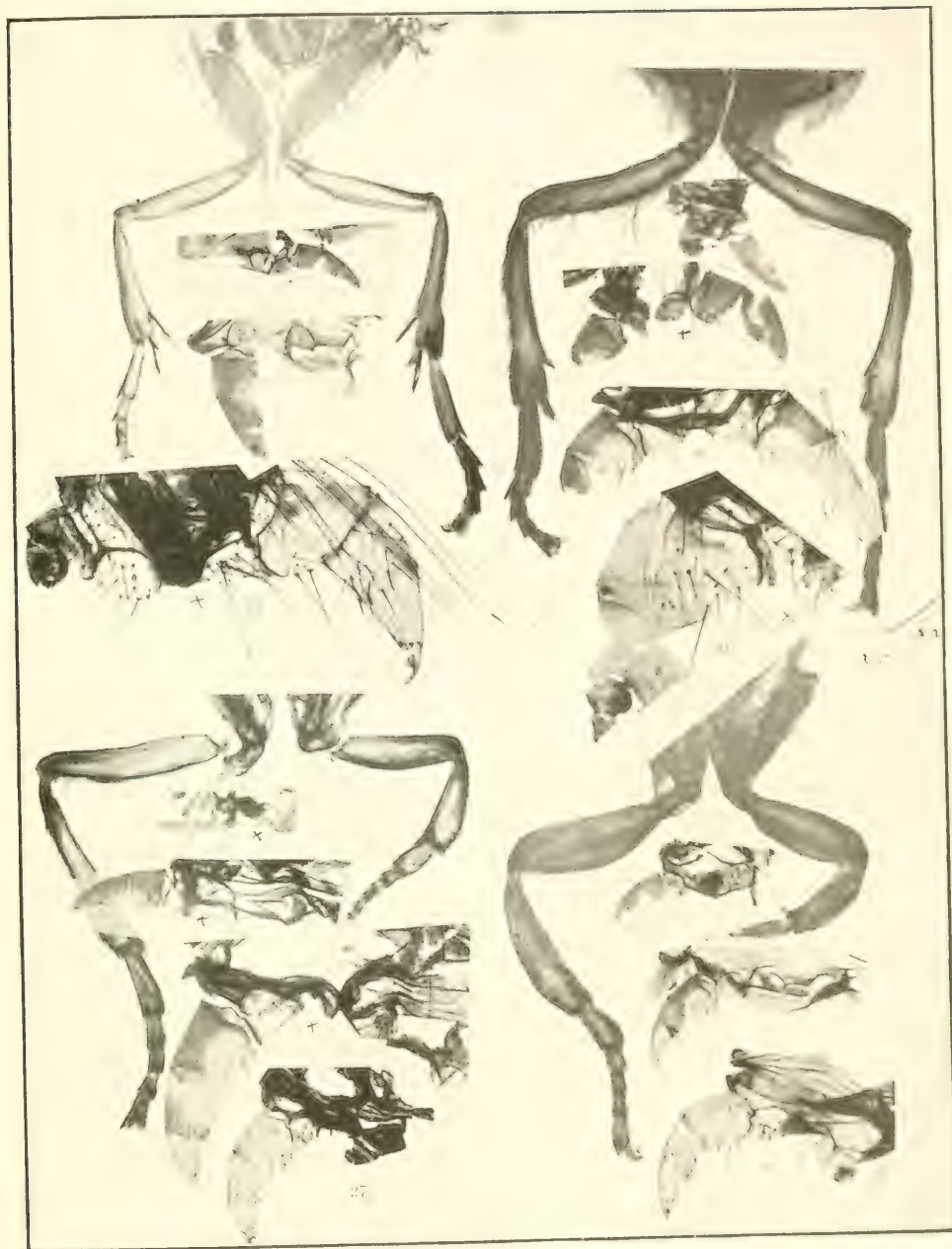


FIG. 25.—Basal amputation in 3rd instar.
 „ 26.—Femoro-tibial amputation in 2nd instar.
 „ 27.—Femoro-tibial amputation in 2nd instar.
 „ 28.—Femoro-tibial amputation in 2nd instar.

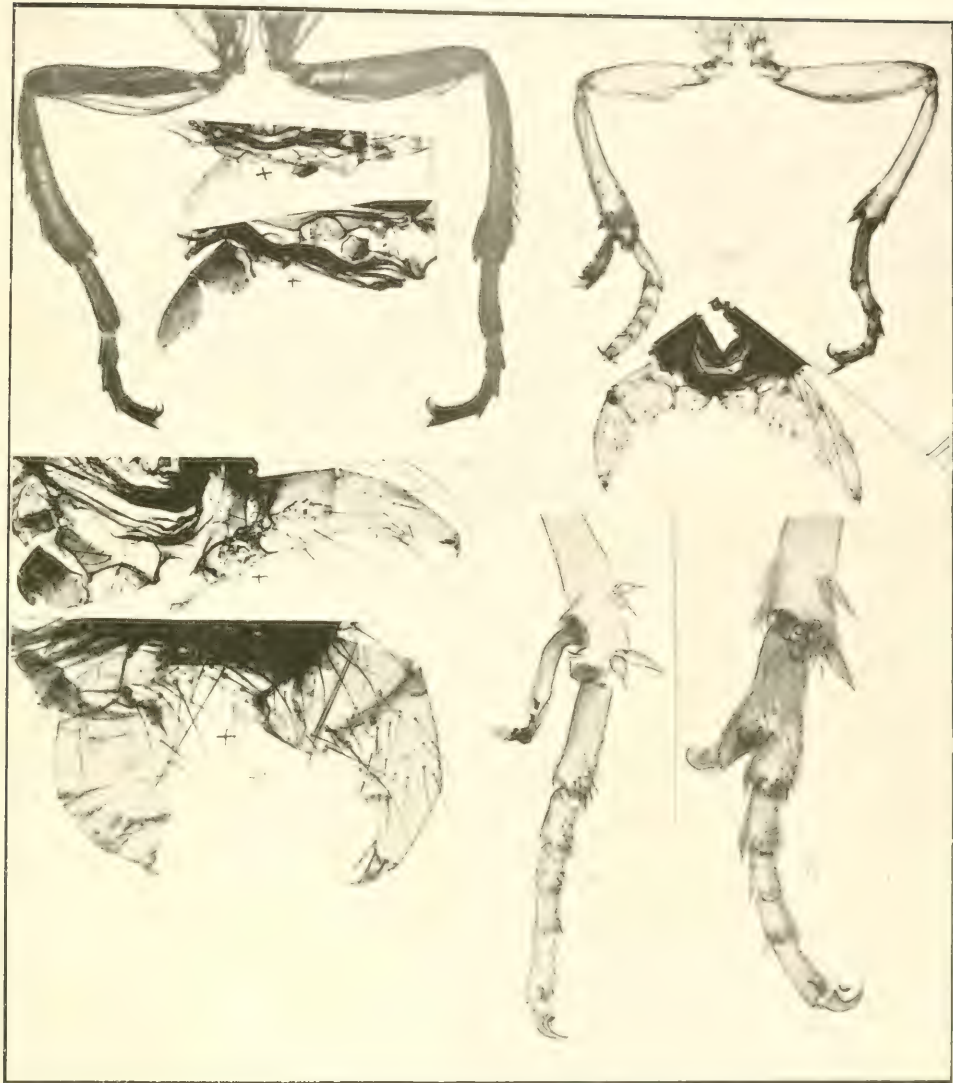


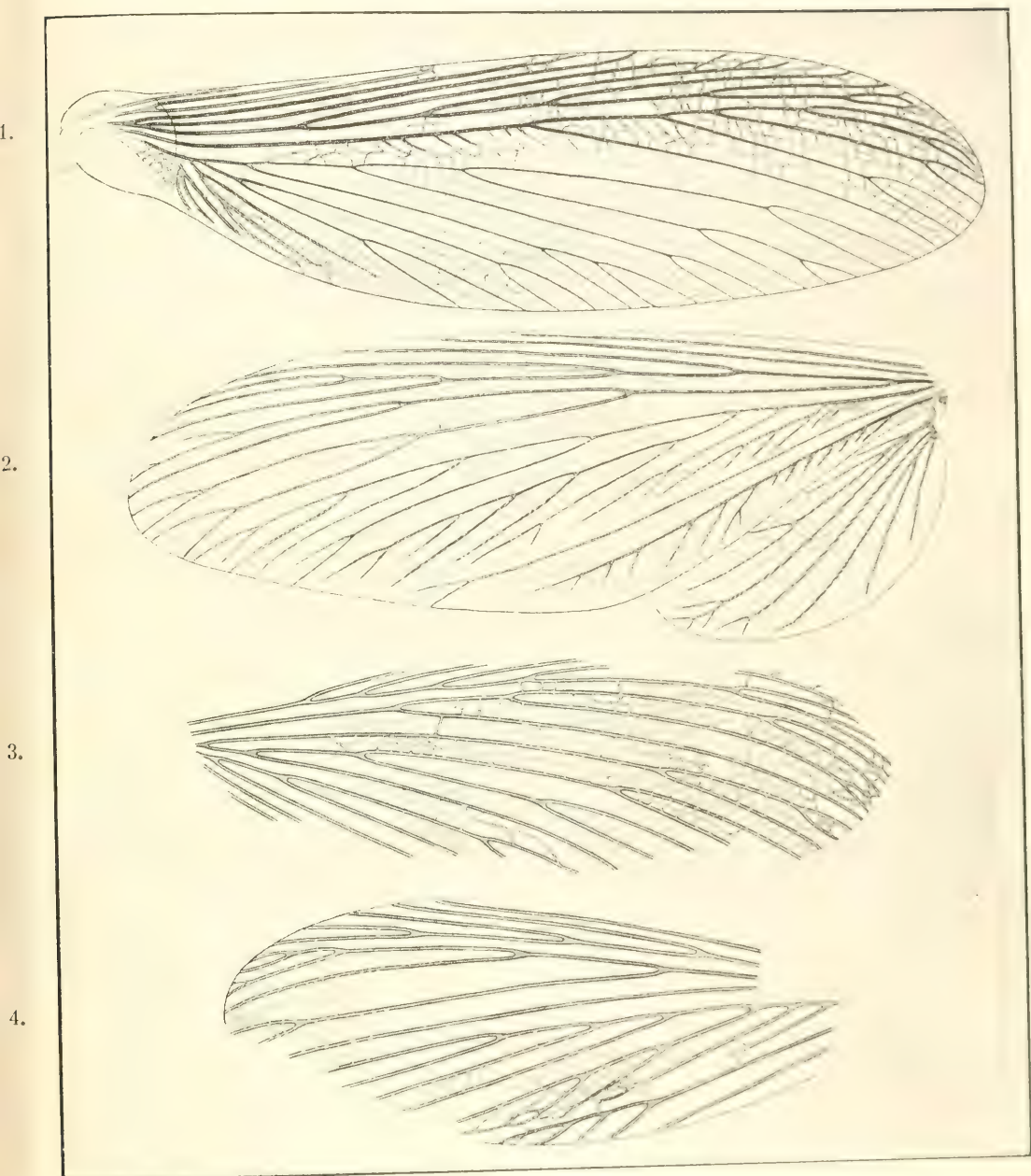
FIG. 29.—Basal amputation in 2nd instar.
,, 30.—Crushing injury in last instar.
,, 31.—Crushing injury in last instar.
,, 32.—Crushing injury in last instar.



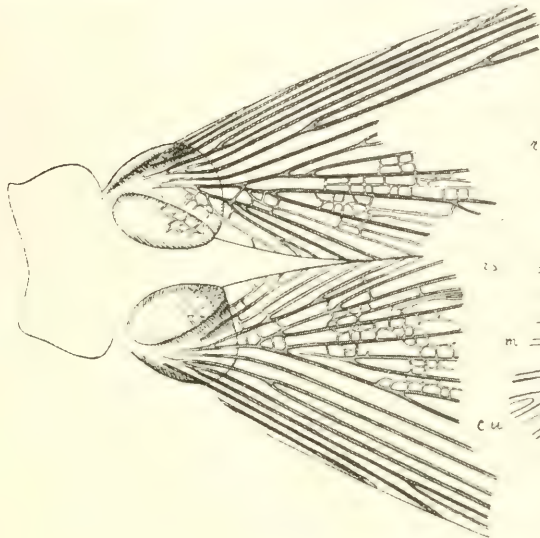
FIG. 33.—Complete amputation in 1st instar.
„ 34.—Crushing injury in last instar.
„ 35.—Crushing injury in penultimate (?) instar.



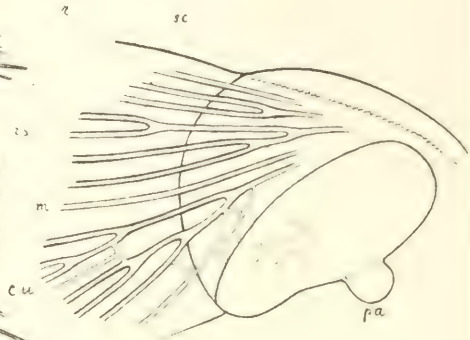
FIGS. 36-40.—Crushing injuries in last instar.



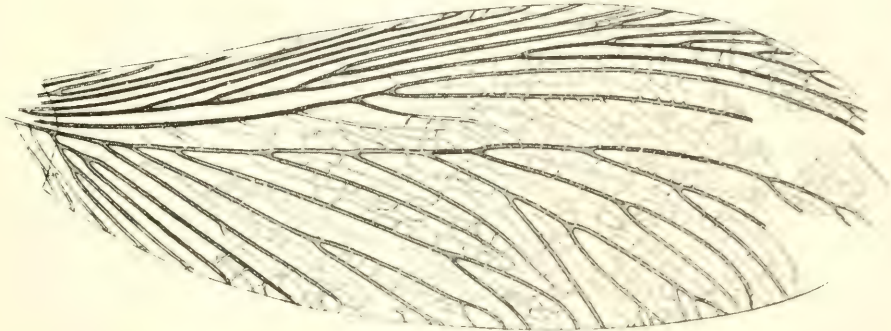
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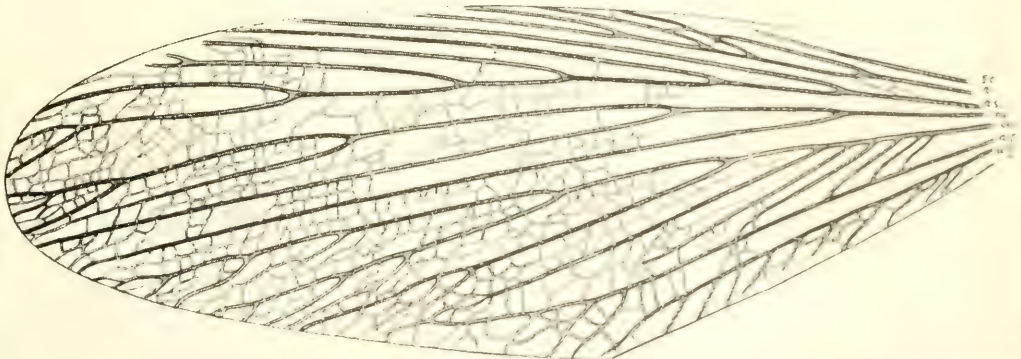
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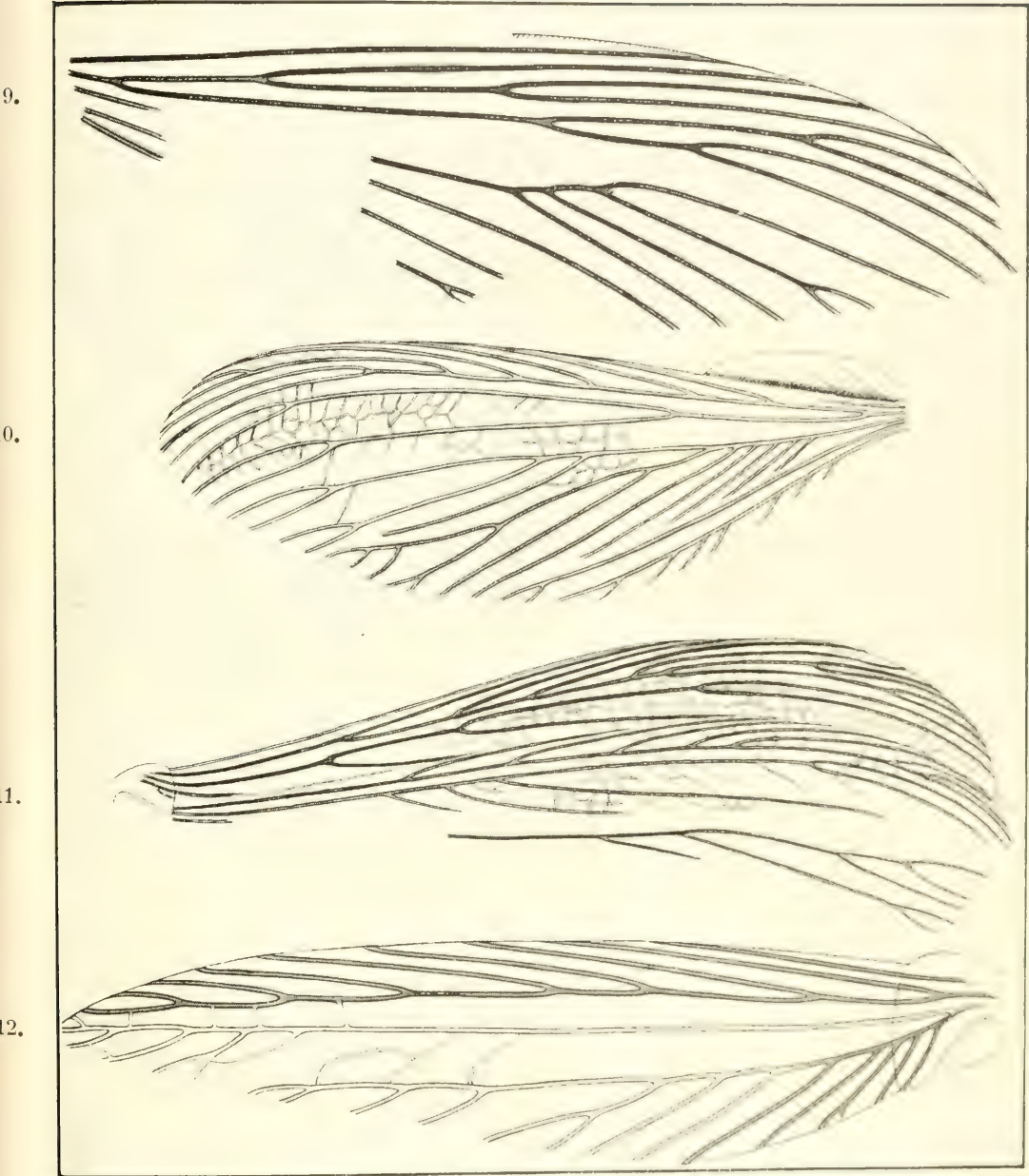


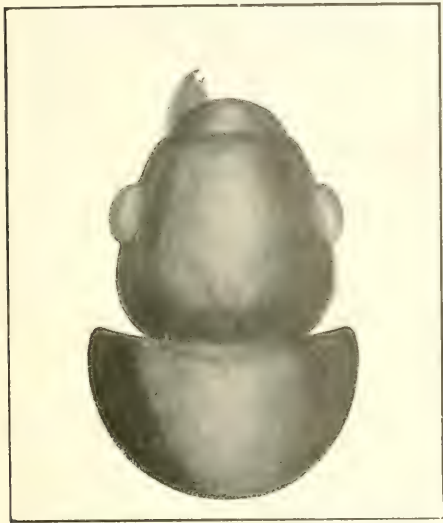
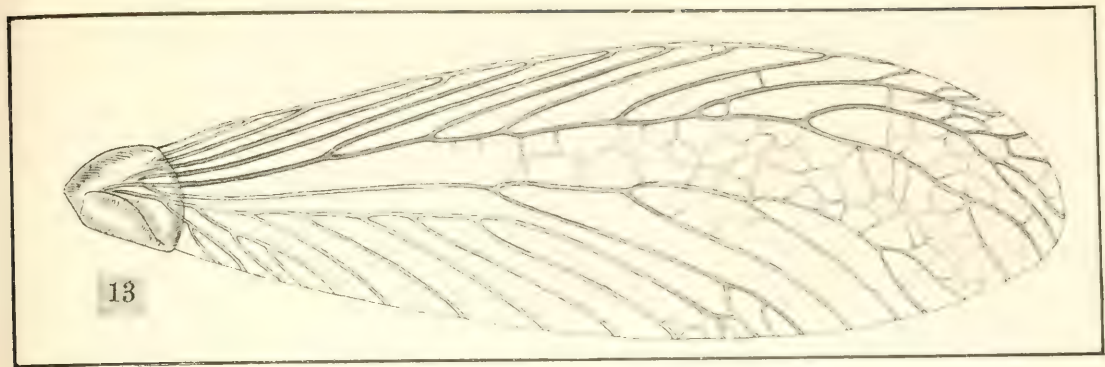
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ROSEN.—FOSSILE TERMITEN.

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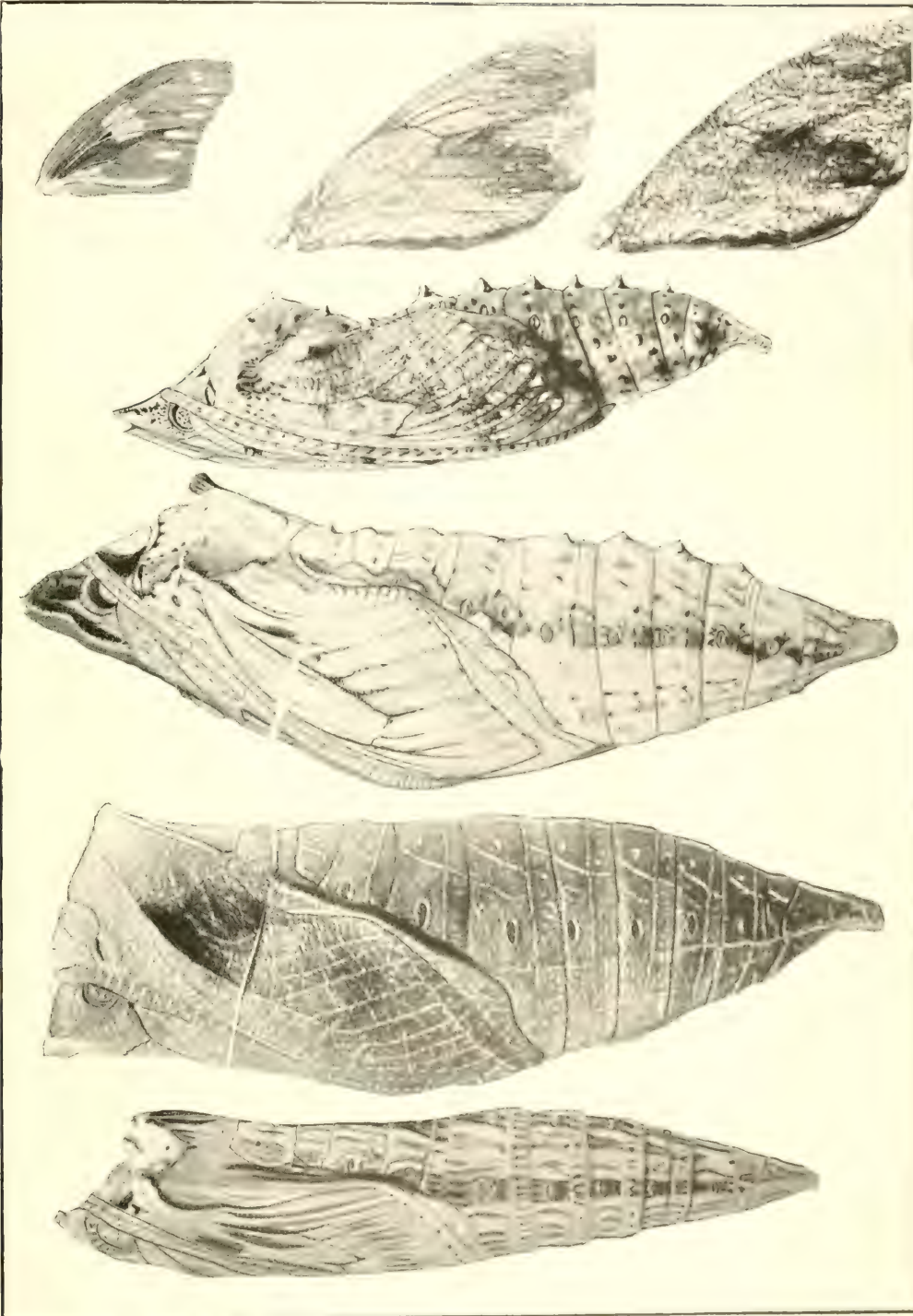
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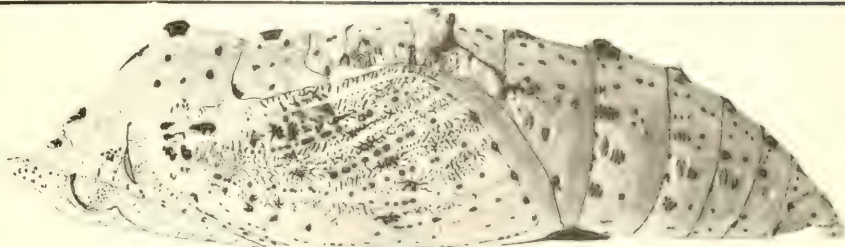
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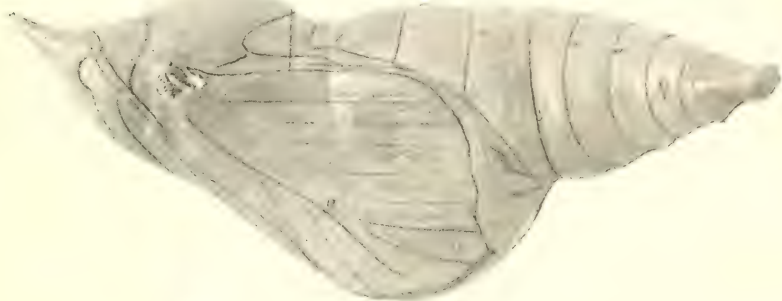
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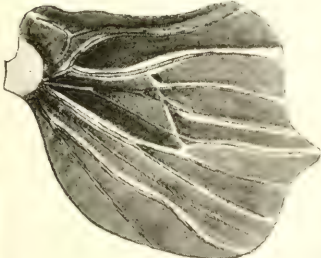
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